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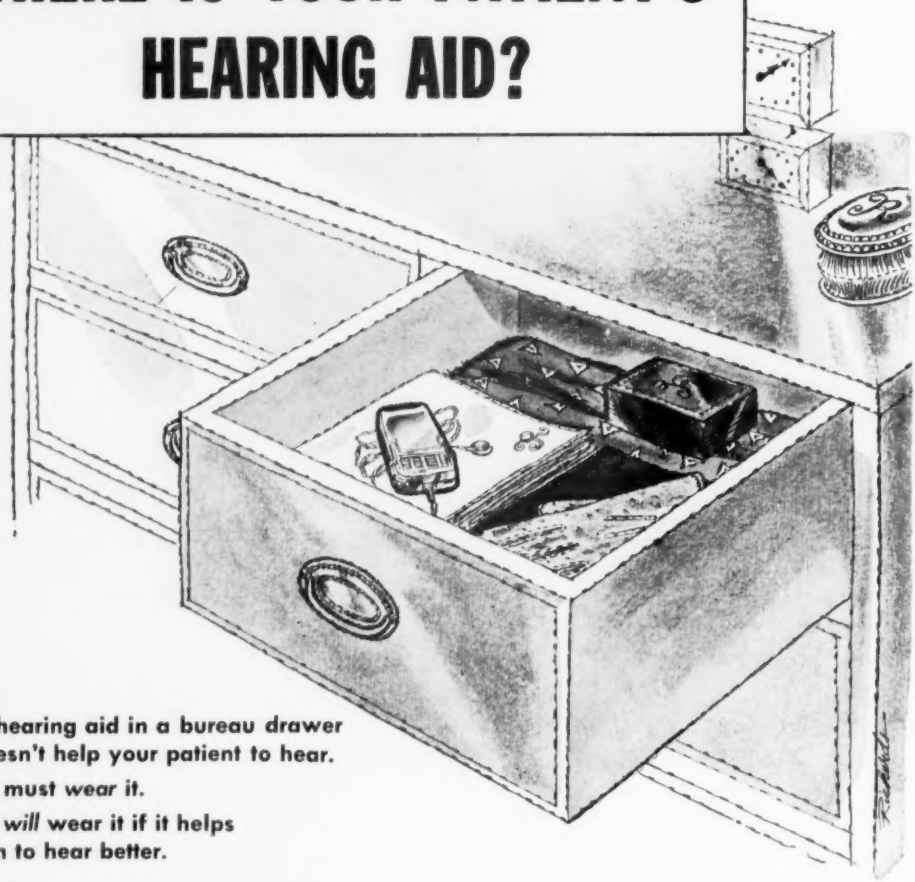

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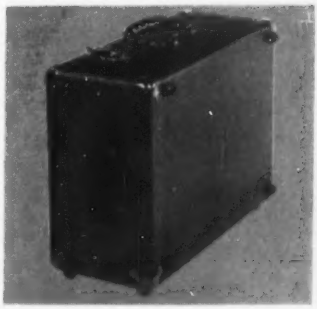

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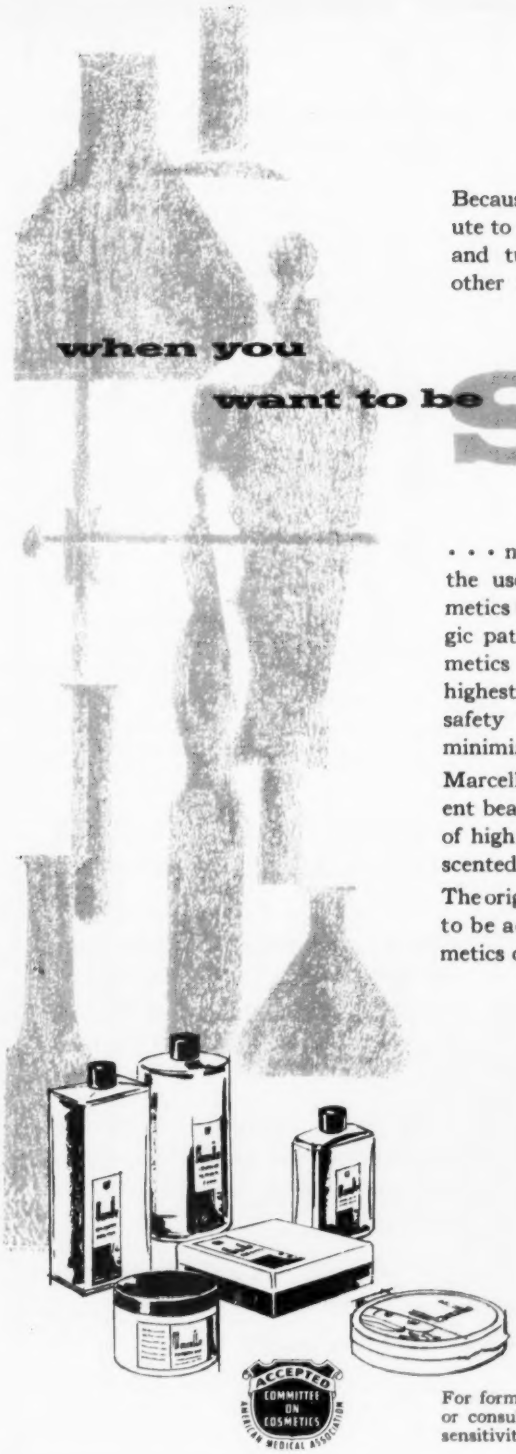

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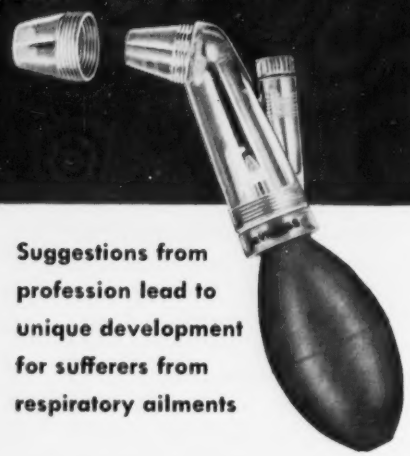

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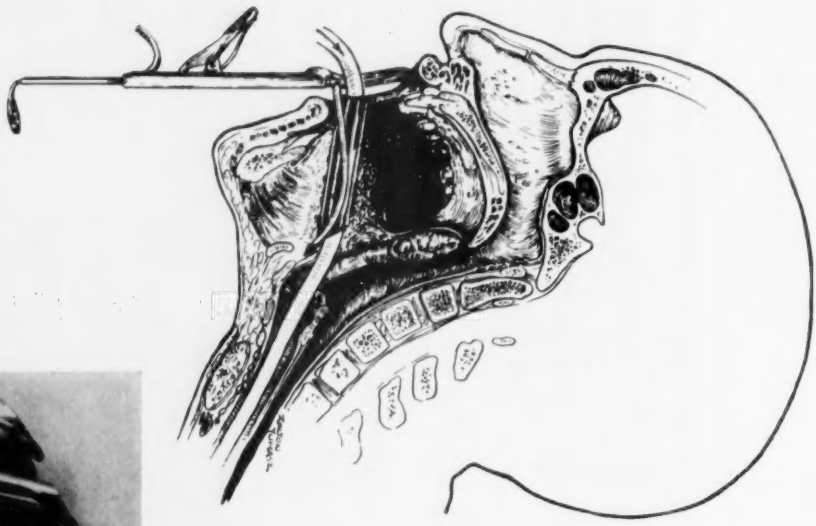

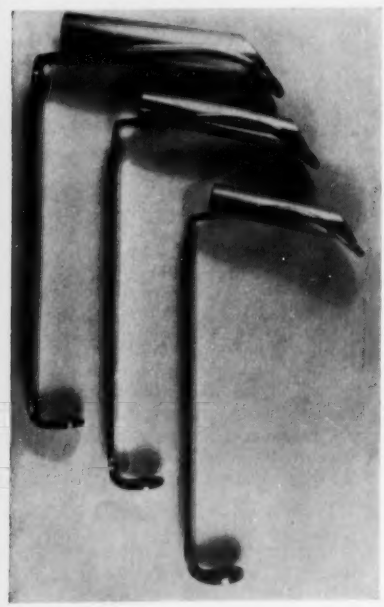

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LONG-TERM RESULTS WITH THE FENESTRATION OPERATION

EDWARD H. CAMPBELL, M.D.
PHILADELPHIA

IN A DISCUSSION of the fenestration operation and its results at the present time, it is extremely gratifying to realize that it is now unnecessary to present evidence or proof of the substantial results that can be obtained with the operation. This is a pleasant contrast to the situation existing 10 or 12 years ago, when the operation and the benefits obtained were viewed with considerable skepticism by a large number of physicians, including many otolaryngologists. If there are skeptics at the present time in medical circles in regard to the value of the fenestration operation, it is a reflection on their progressiveness, for no one who has kept himself informed on the progress and development of this operation can question the substantial results that have been obtained.

While the technical details of the operation have changed somewhat in the past 10 or 12 years, the basic principles have remained the same. The present high degree of success of the operation is based on the carrying out of these technical details by a surgeon not only highly trained in the surgical technique itself but also trained thoroughly in the procedures to determine the suitability of a patient for operation. The degree of success of the operation can be measured to a very great extent by the degree of surgical and diagnostic ability the individual surgeon has developed.

RESULTS OF FENESTRATION

In evaluating the hearing results of the fenestration operation, consideration must be given to: (1) the immediate results in patients properly selected and operated on; (2) the so-called final results after one or two years, and (3) the results after a period of five or more years.

The immediate results in patients ideally suitable and properly operated on should be extremely good, that is, the hearing should be improved to a practical and serviceable level in 90% or more of cases. In the other 8 or 10%, the hearing is not improved and occasionally is made worse. The reasons for the failure of these cases to improve will be discussed later. Approximately 10% of the immediately successful cases will lose all or part of their improvement within 3 to 12 months after operation. There remains then about 80% of the ideally suitable patients who retain practical hearing improvement for at least two years.

From the Department of Otolaryngology, Graduate School of Medicine of the University of Pennsylvania.

The material of this paper, with a few minor changes, was presented before the Section of Otolaryngology of the College of Physicians of Philadelphia, Jan. 20, 1954.

In the cases which will be successful, it has been found that there is considerable improvement of hearing for a day or two following operation but by the second or third day after operation frequently the hearing has receded to well below the preoperative level. This recession appears to be due partly to the reaction of the skin flap overlying the fenestra as a result of the trauma. This reaction of the skin flap and the usual serous labyrinthitis that develops not only depresses the hearing but also suspends the function of the labyrinth. In the great majority of instances this recession of hearing lasts only a few days, and shortly after the gauze packing has been removed the hearing begins to improve and reaches its best point at an average of three to six weeks after operation. The patient then goes through a period of excellent hearing during the subsequent 8 to 12 weeks; then there occurs a period of uncertainty as far as the hearing is concerned.

After the third or fourth month following operation the hearing may do one of three things: (1) remain at its highest level, (2) recede gradually to the preoperative level or below, or (3) recede slightly or moderately to a level better than the preoperative level but not as good as the best level attained after operation.

If the hearing during the period from the 3rd to the 12th month after operation remains at its best level, it is assumed that the postoperative healing reaction has not resulted in reduction of the size of the fenestra by bony regeneration or fibrous-tissue formation. If the hearing recedes during the first year to the preoperative level or below, it is obvious that the newly created fenestrum has been closed by bone or fibrous tissue. If the hearing recedes only a slight or moderate amount from its best level, it is apparent that the cause is a partial closure of the fenestrum by bone or fibrous tissue.

Fortunately, in the great majority of instances in which the immediate result has been good, the hearing remains at that high level past the one-year period, and the result can be considered final except in very exceptional cases. There should be no further change in the hearing after this time because the healing has been completed except in a few instances.

In approximately 8 to 10% of these immediately successful cases, the hearing will recede to the preoperative level or below and a revision may then be considered to remove the regenerated bone and restore the fenestrum. Considerable study of such cases is necessary in order to determine whether or not a revision should be performed.

In some instances, perhaps 15%, the hearing during the first year will recede from its best level after operation to a point substantially better than the preoperative level but somewhat below the high point attained six or eight weeks after operation. Such cases may still be very satisfactory from the hearing improvement standpoint, but often such patients are disappointed in having experienced very good postoperative hearing for a short time and then having some of this improvement lost. In most of such cases, revision cannot be considered because the fenestra is functioning at least fairly satisfactorily, and further manipulation of this partially closed fenestra may result in damage to the membranous labyrinth and cause considerably greater reduction of the hearing.

It has been claimed by some that the final hearing result cannot be estimated at the end of a year after operation. This is true in an occasional patient, but careful study of the postoperative audiograms will show that it is rare for a patient to lose

further hearing from the first to the second year after operation as far as the operation or the original pathology is concerned. In fact, it is unusual for a patient to lose further hearing after a period of seven or eight months. Experience has shown that if bone regeneration or fibrous-tissue formation is going to interfere with the function of the fenestra it does so, in most instances, in the usual healing time of five to eight months.

Since the reports of many hundreds of successful cases by several reliable operators, the skepticism regarding the results for the one- or two-year period has gradually faded from the minds of the great majority of the severer critics of the operation. However, in the past few years there has been spread through both professional and lay circles the thought that during the years subsequent to the so-called final result (at one or two years after operation) there is a gradual loss of hearing from the operated on ear and that at the end of a five- or six-year period the hearing is substantially worse than it was at the end of a year. This rumor has spread without explanations or any facts to support it. It is my purpose at this time to present statistical data of fenestration cases which indicate little or no loss of hearing from the first to the sixth or seventh year after operation in successful cases and offer explanations of the further loss of hearing in certain other fenestration cases. An analysis of the postoperative audiograms and a study of several factors concerned in the postoperative hearing will serve to clarify the situation.

STATISTICS ON LONG-TERM RESULTS

Before presenting my own statistics on the long-term hearing results following the fenestration operation, I will mention those statistics offered by two other operators. In 1951 Adin and Shambaugh [1] published a report on a series of 390 fenestration operations with 5- to 10-year follow-up observations. In 273 (70%) of these fenestration patients the hearing improvement had been maintained for the 5- to 10-year period. Of the remaining 30%, it was found that 20% had lost a part of their initial gain, 5% had no hearing improvement at all, and 5% were considered to have probable bony closures.

In a previous report of clinical observations of patients operated on over a 10-year period, Shambaugh [2] stated that in 207 patients who had received a gain of 15 db. or more for the speech frequencies the average hearing gain after one year from operation was 24 db. The average gain at the end of two years was 23 db., and the gain at five years or more after operation was 24 db. Shambaugh stated that a hearing gain maintained for two years would probably continue to be maintained for at least five years without an appreciable decrease in the hearing.

In 1951, House [3] reported on a study of 88 fenestration patients, on whom follow-up audiograms had been taken for five years. Fifty-five per cent of these patients had less than a 30-db. loss two years following the operation. Thirty-four per cent had less than a 30-db. loss five years following operation. He stated that the hearing of about one-fifth of the patients operated on dropped below the 30-db. level in the three speech frequencies between the second and the fifth year following operation.

From the study of these two operators' reports it appears there is some difference of opinion. Shambaugh's analysis indicates no further reduction of the hearing from the second through the fifth year after operation, while the report of House

indicates that about one-fifth of the patients operated on showed a decline of the hearing during this three-year period. How much decline and in what types of cases was not described in House's report. As far as I am aware, there have not been other reports of long-term results. Further such reports seem desirable in order to more definitely establish the status of the hearing in the several years subsequent to the fenestration operation.

My report of the results after five or more years herewith presented is based on a careful study by personal observation and frequent audiograms over a five- to eight-year period following the fenestration operation on 200 patients. A rather large number of additional patients have been followed for two to four years after operation, but the results of these cases have not been included in this report, as a period of five years following operation has been set as the minimum time in which the results might be designated long-term results. As has been experienced by other operators, I have found that it is difficult to obtain audiograms over a five-year period on operated patients. Many patients during such an interval of time move to a different locality and do not go to the trouble to return for a check-up and retesting because they have retained good serviceable hearing and are satisfied to have it left alone. It has been my experience to discover that a much greater percentage of fenestration patients who have had an unsuccessful result will return frequently and for long periods for a follow-up and retesting than those patients who have had a successful result. The latter patients are satisfied and often do not return until their hearing has become depressed, and then they become alarmed. In such instances, the depressed hearing is usually the result of some temporary condition, such as nasal infection, allergy reaction, or secretory otitis. When patients return at such times as these, the audiograms naturally indicate a reduction of the hearing. In an analysis of statistics on long-term results, the audiograms taken at such times when the hearing is depressed must be discounted if a true estimate of the hearing is to be made. It is difficult to induce many such patients to return for testing when their hearing has again improved and at a time when a true estimate can be made for comparison with previous tests. It is the common experience, therefore, that a review of five-year results will show a rather high percentage of failures among those patients who have returned faithfully for a period of five years or more. In analyzing my long-term results, I have not accepted the audiograms my patients have given me at a time when their hearing was temporarily depressed, but have insisted on retesting them when this depressed state subsided. It is only by careful study and repeated testing that the true hearing can be determined in many of these patients.

RESULTS IN 200 FENESTRATION PATIENTS

In reporting the results in these 200 fenestration patients, the audiograms of whom have been followed for five years or more, I will separate them into three groups as follows: (1) a group of 130 patients in whom the operation has been successful, that is, those who have had improvement to the practical hearing level for the three speech frequencies; (2) a group of 49 patients in whom the operation has not been successful, inasmuch as the hearing either was not improved to the practical hearing level or had been satisfactorily improved for a while with later partial loss of the improved hearing; (3) a group of 21 patients in whom the hear-

ing had been improved to a practical level, with subsequent loss of the hearing to the preoperative level or below. All these 21 patients had revisions, 45% of which were eventually successful.

Group 1.—In the 130 successful cases (Table 1), the average decibel loss before operation was 49.2 for the three speech frequencies; the average decibel loss one year after operation was 27.1; the average loss two years after operation was 28.9 db., and the average loss five years after operation was 27.6 db. Among these 130 fenestration cases, there were 43 who returned for audiograms seven years or more after operation. Of these 43 cases (Table 2), the average decibel loss before opera-

TABLE 1.—*Hearing Results for the Three Speech Frequencies One Year, Two Years, and Five Years After Operation in 130 Successful Cases*

Average decibel loss before operation	49.2
Average decibel loss 1 yr. after operation	27.1
Average decibel loss 2 yr. after operation	28.9
Average decibel loss 5 yr. after operation	27.6

TABLE 2.—*Hearing Results for the Three Speech Frequencies One Year, Five Years, and Seven Years or More After Operation in Forty-Three Successful Cases*

Average decibel loss before operation	48.6
Average decibel loss 1 yr. after operation	24.5
Average decibel loss 5 yr. after operation	26.5
Average decibel loss 7 yr. or more after operation	28.2

TABLE 3.—*Hearing Results for the Three Speech Frequencies One Year, Two Years, and Five Years After Operation in Forty-Nine Unsuccessful Cases*

Average decibel loss before operation	50.6
Average decibel loss 1 yr. after operation	42.8
Average decibel loss 2 yr. after operation	46.4
Average decibel loss 5 yr. after operation	49.2

tion was 48.6, the average loss one year after operation was 24.5 db., the loss five years after operation was 26.5 db., and the loss seven years or more after operation was 28.2 db.

Group 2.—In the 49 unsuccessful cases (Table 3), the average decibel loss before operation was 50.6. The average loss one year after operation was 42.8 db.; two years after operation, 46.4 db.; five years after operation, 49.2 db.

Group 3.—In the 21 patients who had successful results for a few months and then lost the improved hearing and had the fenestra revised, the average decibel loss before operation was 45.8 db. The average loss just before revision was 50 db. Six of the 21 revisions were successful. Of the 15 cases in which the first revision was not successful 6 had a second revision, and 3 of these were successful.

COMMENT ON RESULTS IN THE THREE GROUPS

In a study of the results obtained in the first group of 130 successful cases, it is noted that the average hearing five years after operation is only 0.5 db. worse than at the end of one year. This would appear to indicate that those patients who

have retained a satisfactory improvement of hearing for one year after operation will retain the hearing without further significant loss for at least five years. In an analysis of the results in 43 of these 130 successful cases, who had been followed seven years or longer, there is noted an average 2 db. loss at five years over the level at one year and a further loss of 1.5 db. in the subsequent two years or more. This loss of 3.7 db. over a 7- to 10-year period may or may not be significant. It is noted also that the average loss in these 43 cases between the end of the first year and the end of the fifth year is 2 db., while the average loss of the 130 cases, of which the 43 is a part, is only 0.5 db. It is probable that the greater the number of cases in which the hearing is averaged the more accurate will be the estimate of the hearing, both before operation and at any period after operation.

In a review of the results shown in the group of 49 unsuccessful cases, it is observed that an average loss of 6.4 db. has occurred between the end of the first and the end of the fifth year. This would appear to indicate that a patient who has not had a successful operation will gradually lose some hearing during the years subsequent to operation. A long-term study of the 21 additional unsuccessful cases cannot be made, as all of them were revised in from one to three years after operation.

FACTORS CONCERNED IN THE POSTOPERATIVE HEARING

A discussion of certain factors concerned with the postoperative hearing may perhaps help in analyzing the results obtained in fenestration cases. Among such factors may be mentioned psychological reactions of the patient, temporary inflammatory or allergic conditions of the nose and ears, secretory otitis, the degree of tinnitus present, emotional and nervous disorders, labyrinthine hypertension, auditory nerve degeneration, and further advancement of the otosclerotic process.

In the careful observation of fenestration patients over a 14-year period, certain psychological reactions have been noted which tend to give the impression in the patient that the hearing improvement following the fenestration operation is not maintained over a 5-year period or longer. One of the commonest reactions of a patient is one that is concerned with the hearing in the ear not operated on during the years following operation. Patients have frequently told me at the end of four or five years after operation, and sometimes earlier, that their hearing was not as good as it had been, and they felt that the operated on ear was failing. Repeated testing in such cases has indicated that the hearing in the fenestrated ear has shown no significant loss, as shown in the above statistics, but the hearing in the untreated ear frequently has failed somewhat owing to further advancement of the otosclerotic process. It is the general custom of fenestration operators to select for operation the ear in which the hearing is worse. This means that frequently the untreated ear may have had only a 35 to 40 db. loss, while the worse ear, which is operated on, may have a 45 to 50 db. loss. When the operation brings the hearing in the worse ear to a level of 25 db. or better, it gives the patient good hearing but not perfect hearing. Such a patient is still getting some hearing benefit from the unfenestrated ear with the 35 to 40 db. loss, and, when the hearing in this ear further deteriorates during the subsequent years, owing to further advancement of the otosclerotic process, the patient naturally does not hear as well; and unless the patient has means of accurately testing each ear separately, he will not realize that the further hearing impairment is concerned with the untreated ear rather than the treated one. This

further loss of hearing is noticeable not only to the patient but also to his friends and his home doctor. Unless such persons understand the reason for the further hearing impairment, the thought is very apt to be spread that the operative result is not holding up, leading to the often unfair prejudice against this surgical treatment.

Another reaction of the patient that must be considered in the postoperative estimation of the hearing is the carelessness of the patient in the response to the audiometric tests. In the first year after operation the patient is interested in the hearing tests and pays strict attention, thus giving audiograms that represent the true status of hearing. When the year has passed and the patient has been told that the uncertain period has passed, the subsequent tests are very apt to be inaccurate because of the waning attention of the patient. The patients learn various methods of their own to test their hearing, and they are fully aware of even a few decibels loss. They are therefore not interested in what the audiograms show and are apt to be careless in their response. Such inattention to the tests frequently gives audiograms that appear to indicate reduced hearing when the hearing has not actually become less. The technician must be constantly on the watch for such careless responses and must urge the patient to give the tests strict attention and concentration. A difference of 10 db. or more in the audiometric response is frequently discovered when such careless responses are corrected.

At any time following the operation, such conditions as nasal colds, allergic reactions, and secretory otitis may temporarily depress the hearing, and an audiogram taken at these times may show considerable reduction of the hearing from the level previously shown. Audiograms for comparison purposes must be taken when such factors are not present if a true estimation of the hearing at any given time is to be obtained. Fenestration patients are just as susceptible to the condition of secretory otitis as anyone, and it is well known how protracted this condition may be and can depress the hearing for long periods of time. Audiograms of a fenestration patient during such periods are worthless as far as comparison with previous audiograms are concerned. It is quite possible for a prolonged secretory otitis to result in a permanent reduction of the hearing in a fenestration patient the same as it may do in any person. This must be considered as a possible cause of a loss of hearing in those persons operated on who actually do have some loss in the years subsequent to operation.

There are other factors that tend to give false audiograms frequently in fenestration patients. Such conditions as fatigue, emotional disturbances, nervous disorders, and increased tinnitus may temporarily produce depression of the hearing. I have seen numerous instances in which patients have given a poor audiogram after a hard day's work or an emotional upset. Most of the fenestration patients have some tinnitus in the treated ear as well as the untreated ear. It is well known how tinnitus may be considerably increased at times by exposure to noise, by strenuous activity, either mental or physical, by emotional disturbance, and by elevated blood pressure. Audiograms taken during a period of increased tinnitus will fail to show the low level of hearing anticipated because of the masking effect of the tinnitus.

In considering the factors that can influence the hearing during the years following operation, one must give attention to certain conditions that may produce a lasting depression of the hearing but which have no bearing on the fenestration

operation itself and its success or failure. I refer to such conditions as secondary auditory nerve degeneration, further advancement of the otosclerotic process, and intralabyrinthine hypertension. The condition of secondary nerve degeneration in otosclerosis has always been vague and uncertain and one that as yet has not been satisfactorily explained. It is well known that auditory nerve impairment at the higher frequency levels is present in many otosclerotic patients and may occur at any stage of the otosclerotic process and at any age. It has been observed that if a patient with otosclerosis having some auditory nerve degeneration is operated on, the nerve deterioration will continue to progress and within a few years may advance to the point of considerably reducing the hearing through the speech frequencies and result in the failure of an otherwise successful operation. Statistics have been presented which tend to indicate that the fenestration operation retards further nerve degeneration in the ear operated on, but such statistics are not very impressive. It seems more likely that auditory nerve degeneration is independent of the otosclerotic process except in those unusual instances in which there is direct invasion of the inner ear mechanism by extension of the bony deposit.

TABLE 4.—*Types of Hearing Results Obtained*

		Hearing Before Operation, Db.							Hearing 1 Yr. and 5 Yr. After Operation, Db.						
Case	Age, Yr.	128	256	512	1024	2048	4096	8192	128	256	512	1024	2048	4096	8192
P. D.	35	45	47	48	51	47	50	25	55	50	60	45	45	65	40
									65	60	65	60	40	70	35
C. K.	16	50	50	50	50	40	45	40	30	30	25	15	20	40	40
									35	35	25	20	20	45	40
E. S.	48	35	35	38	35	28	40	45	20	15	25	20	15	30	40
									15	20	25	20	10	30	45
L. Y.	36	45	54	65	55	55	45	65	20	25	35	30	30	50	65
									30	30	35	35	30	45	70

It is generally considered that the fenestration operation does nothing to stop or retard further advancement of the otosclerotic progress. In the great majority of cases, such further progress would result only in more complete fixation of the stapes and the deposition of bone in the neighborhood of the stapes footplate. Further extension of the bony deposit in this location would not cause any reduction of hearing following a successful fenestration operation. However, if there should be a substantial increase of bone deposit in and around the round window, further gradual reduction of hearing would occur and might result in profound deafness. If the process advanced into the cochlea, the hearing would be reduced and perhaps destroyed. If the otosclerotic deposit filled in the newly created fenestra, the hearing would gradually reduce to the preoperative level or lower. These conditions are possible but, fortunately, are not common, and do not need to be feared as a cause of depressed hearing following a successful operation.

From the study of the hearing results for a period of five or more years after operation, it appears, therefore, that in those cases which are successful—that is, in those patients who retain hearing to a practical serviceable level for one or two years after operation—there is no further loss of hearing in the ear treated during the subsequent four or five years except in those instances which have been mentioned above and which have no bearing on the operation itself.

RESULTS IN UNSUCCESSFUL CASES—CAUSES OF FAILURE

It is a different matter, however, in those cases in which the operation has not been successful. In spite of the important strides that have been made in devising techniques to prevent postoperative closure of the fenestra, complete or partial closure of the fenestrum by bone regeneration or fibrous-tissue formation during the few months after operation is still the chief cause of failure of the operation.

The great majority of otosclerotic patients who receive the fenestration operation do so before the stapes has become completely fixed in the oval window. It will be noted in the statistics herewith presented that the average loss of hearing before operation in the conversational frequencies is about 49 db. A loss of this degree would represent an incomplete fixation of the stapes, as complete fixation of the stapes in the oval window would produce a 60 to 65 db. loss of hearing. At 49 db. loss, therefore, there would still be some conduction of sound through the partially occluded oval window. A successful fenestration operation would naturally give satisfactory hearing improvement in such cases, but if subsequently the fenestra became closed, the hearing would recede to at least the preoperative level. In the course of another four or five years, however, there would, in perhaps the majority of cases, be further advancement of the otosclerotic process around the stapes footplate and result in a further gradual loss of hearing as more complete fixation of the stapes produced a more complete obstruction to the conduction of sound through the oval window. An increased loss of hearing five years after operation over the level of one year after operation is exactly what might be expected in at least many of the unsuccessful cases. In this report there is found, in 49 unsuccessful cases, an average loss of about 7 db. from the end of the first year after operation to the end of the fifth year.

While the closure of the fenestra subsequent to operation is probably the commonest cause of failure, there are other factors which may also be present at the operation or later that interfere with a successful result. Some of these factors are dependent on the skill and technique of the operator, while others have little or no connection with the operative ability. Second only to bone regeneration as a cause of failure of the operation is postoperative serous labyrinthitis or labyrinthosis. Extreme gentleness in the creation of the fenestra will, on the whole, produce milder and less harmful labyrinthine reactions, but in spite of the utmost care, unusually severe labyrinthosis may develop, which may have a deleterious effect on the postoperative hearing. The factors concerned in these reactions are not completely understood, but at times they will not only prevent improvement of hearing but occasionally may cause the hearing to become considerably worse than before operation.

In the above discussion of postoperative labyrinthosis, I am not referring to the effect of the hearing that is occasionally caused by injury to or evulsion of the membranous labyrinth during the creation of the fenestra. Such an accident is apt to result in profound loss of hearing, but it has been observed that evulsion of the membranous labyrinth in the ampulla region of the horizontal canal can occur without impairing the cochlear function. This has been experienced by operators both in the labyrinth fenestration operation and in the operation for destruction of the labyrinth in Ménière's disease.

Another cause of failure has been attributed to the fact that blood has entered into the perilymph space during operation and has caused a later reaction in the cochlea, resulting in depression of the hearing. It seems unlikely that this is an important factor. In the great majority of instances it is likely that blood in varying amounts enters the perilymph channel during the creation of the fenestra and the closing of it with the skin flap. It is probable that this relatively small amount of blood is satisfactorily disposed of in the healing reaction without producing damage to the hearing mechanism.

A few failures must be attributed to wrong preoperative diagnosis. In spite of the greatest care in testing patients, an occasional one will be operated on who has a primary perceptive hearing loss rather than a conductive loss. In those patients who appear to have otosclerosis with some secondary auditory nerve degeneration, the audiometric tests may be confusing and result in a wrong interpretation, particularly of the bone-conduction tests. This can be true especially in those patients who have considerable tinnitus associated with a rather severe degree of deafness. The tinnitus is frequently confused with the testing tones, and extreme care is necessary in making the tests to obtain a response from the patient that represents his hearing of the testing tones and not the tinnitus.

Occasionally a patient is encountered who will deliberately deceive the tester because he has decided to give the operation a trial no matter what the tests may indicate. These patients know from previous testings what response is necessary to make them fit into a suitable classification. Such patients may deliberately indicate satisfactory hearing by bone conduction when they do not hear the tones, and be classified as otosclerotics when their deafness is primarily of a perceptive type. A repetition of the tests before operation will usually reveal inconsistencies of response in such cases that will lead to the proper diagnosis of the type of deafness. While the fenestration operation in cases of primary otosclerosis with a moderate degree of secondary nerve degeneration is apt to be successful in improving the hearing in the low and middle frequencies, to at least a fairly satisfactory degree, the operation on patients with primary perceptive deafness will always result in unimproved hearing and may produce considerable reduction of the hearing.

Infections of the ear cavity may also be a major cause of failure. Such infections may be primary or secondary. The primary infections are those that occur as a result of the operated on area becoming contaminated at the time of operation. The secondary infections are those that appear several days or weeks subsequent to operation as a result, usually, of the patient's getting infective organisms into the ear cavity through his own carelessness.

The primary infections are the more serious but fortunately are not common, as the extremely aseptic surgical technique, the use of antibiotic ointment with the ear packing, and antibiotics systemically prevent such infections except in an occasional case. When a primary infection does develop, it produces a severe inflammatory reaction in the middle-ear cavity as well as around the skin flap, fenestra, and excavated mastoid cavity, which is very likely to result in considerable reduction of the postoperative hearing over the preoperative level. I have experienced a few such infections, but, surprisingly, they have not caused any severe complications except the failure to obtain satisfactory improvement of hearing.

Secondary infections of the ear cavity are rather common, but fortunately they rarely have any effect on the hearing result. They do, however, delay tremendously the healing of the operated on area. These infections occur chiefly in women who, in spite of the repeated warnings that are given them, will not take the precautions necessary to keep their hair out of the ear. It appears that lay people cannot fully understand the dangers of bacterial contamination, and frequently they permit hair or water to get into the ear shortly after operation, which results in infection with purulent discharge, swelling of the skin, accumulation of granulations, and the greatly prolong healing time. Although such infections are common and at times severe, caused usually by the Staphylococcus or Pseudomonas, they do not seem to affect the postoperative hearing result unless there is a perforation of the drum membrane which has occurred during the operative procedure. In some of these secondary infections, the ear cavity continues to drain for many months in spite of active antiseptic and antibiotic treatment. At times such infections invade unexenterated mastoid cells and produce a typical mastoid infection that will drain for perhaps two or three years with slow necrosis of the cellular structure of the mastoid. I have reoperated on two such cases at two and three years after operation because of the continued drainage. In both cases a typical mastoiditis, with necrotic cell walls and pus and granulations in the cells, was found. In both patients the ear cavity became dry and healed in a short time following the complete removal of all infected mastoid cells.

Another reason for failure of the hearing to improve satisfactorily after fenestration operation is the presence of a perforation in the tympanic membrane. It is necessary in the surgical technique to manipulate considerably the drum membrane and the attached skin flap. Occasionally small lacerations in the skin flap occur and at times also a perforation in the tympanic membrane. The great majority of these perforations heal spontaneously within a few weeks after operation, but occasionally they show no tendency to heal in the usual time. In such cases active treatment of the perforation must be instituted in order to close it. It is always noted in cases in which the perforation persists for six or eight weeks after operation that the hearing does not improve to the extent that has been anticipated. When the perforation is finally healed, however, the hearing improves to the expected level if the other details of the operative procedure have been satisfactorily carried out. Perforations are not an important complication if the area operated on can be kept free of infections.

CONCLUSIONS

In a study of the hearing results over a period of five or more years after the fenestration operation, it is apparent that the hearing improvement that is present a year after operation can be maintained at approximately that level for years unless other factors that have no connection with the original condition or the operative technique intervene to impair the hearing. Such factors may be temporary or permanent, and their nature and effects have been discussed. Without a detailed analysis of these various factors that may reduce the hearing in cases operated on, there is very apt to develop the thought in both lay and professional circles that the long-term hearing results in fenestration patients are not good. When a careful study is made, however, and the influence of such factors is properly considered, there remains the definite impression that fenestration patients with successful

results do not subsequently lose their improvement unless certain conditions develop which have no connection with the operation. These factors that might impair the hearing are, in a large measure, no more applicable to the hearing in the fenestration patient than to the hearing in any person. It is important for the otosclerotic patient as well as lay and professional people to understand this true situation regarding the postoperative hearing in order that the patient with otosclerosis will not be diverted from the great benefits that can be derived from the fenestration operation.

SUMMARY

Statistics regarding the long-term hearing results on 200 fenestration patients observed and tested audiometrically over a period of five years or more after operation are presented. In a group of 130 successful cases, the average hearing for the three speech frequencies was only 0.5 db. worse at the end of five years than it was at the end of the first year. In 49 unsuccessful cases, an average loss of 6.4 db. occurred between the end of the first and the end of the fifth year.

These results indicate that those patients who have retained a satisfactory improvement of hearing for one year after operation will retain the improved hearing without further significant loss for at least five years. In the unsuccessful cases, however, a further loss of hearing during the years subsequent to the operation can be anticipated.

Several factors concerned in the postoperative hearing are discussed, such as psychological reactions of the patient, inflammatory or allergic conditions of the nose and ears, secretory otitis, presence of tinnitus, emotional and nervous disorders, intralabyrinthine hypertension, auditory nerve degeneration, and further advancement of the otosclerotic process.

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BRONCHOGRAPHY

A Study of Its Techniques and the Presentation of an Improved Modification

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EVER since Jackson,[1] more than 30 years ago, first began the instillation of bismuth subcarbonate into the tracheobronchial tree so as to outline its anatomy by x-ray, medical men everywhere have made efforts to improve the technique of bronchography.

The first major step was made in 1921, when Sicard and Forestier [2] introduced a contrast medium which was radiopaque, nontoxic, and was absorbed by the lung. This was called iodized oil (Lipiodol). Since then, until within the past few years, iodized oil or chloriodized oil (Iodochlorol) has been used exclusively as the contrast medium introduced into the tracheobronchial tree.

Recently a water-soluble contrast medium has been introduced, which may supplant iodized oil. However, comparison and evaluation of these two substances will be discussed later.

Somerfield [3] in 1942 stated that there are five primary methods of bronchographic technique:

1. Supraglottic, or laryngeal
2. Nasal
3. Transglottic
4. Subglottic, or intercricoid
5. Bronchoscopic

The supraglottic, or laryngeal, method, reduced to its simplest explanation, is the instillation of the contrast medium through the mouth and pharynx and dropping it through the larynx into the trachea and bronchi. The pharynx is anesthetized with cocaine or tetracaine (Pontocaine), either by spray or a cotton-tip applicator. The piriform sinuses and the larynx are likewise anesthetized, followed by dropping the anesthetic solution through the larynx, thereby anesthetizing the tracheobronchial tree by means of its spread by cough.

After the patient is anesthetized in this manner, the contrast medium is then dropped through the larynx, usually by means of a laryngeal tip or catheter; the direction of stream is guided by observation through the laryngeal mirror. After sufficient medium has been instilled, the patient is fluoroscoped and positioned in such a manner as to outline the various segments desired.

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Forestier and Leroux,[4] in 1935, introduced the nasal method of instillation and were followed in this technique by Gosselin and Perron,[5] Dormer and his associates,[6] and many others. This involves the introduction of the anesthetic as well as the contrast medium into the nose, thence by gravity through the nasopharynx into the pharynx, larynx, trachea, and bronchi. In this method the anesthetic agent is introduced usually by means of a soft rubber catheter in the anterior portion of the nose. The head is tilted back slightly, and the solution is injected very slowly so that the patient's pharynx and larynx may be anesthetized with a minimal amount of gagging and coughing. During the injection, the tongue is held out of the mouth so that none of the anesthetic solution or contrast medium can be swallowed. As is well known, it is very difficult to go through the swallowing act while the tongue is pulled forward. After the entire route from the nose to the bronchi is well anesthetized, the medium is introduced by the same method and finds its way in the same fashion to the bronchi. The patient is then positioned as desired, to obtain the x-rays.

There have been several modifications of this method. Rolin [7] passed a catheter just to the nasopharynx and then instilled the anesthetic and contrast medium by gravity, while Schmidt [8] and Heublein and Gilfillan [9] continued to pass the catheter on down through the larynx and into the trachea.

Miller and his associates [10] employ the use of a special aerosol technique, using oxygen or air pressure. They nebulize 8 cc. of 0.5% solution of tetracaine in a glycerin and detergent base. The patient inhales this mist for five minutes at 6 liters of oxygen per minute, then at 10 liters per minute until the entire solution is used. The nostrils are taped shut before the anesthetic is administered so that the patient will be sure to take the anesthetic directly into the pharynx and larynx. The balance of the procedure is followed by injecting the iodized oil through the nose so that the oil passes through the larynx into the trachea; this is followed by positioning the patient in a way that all the segments will be filled.

The transglottic method, as used by Rudman,[11] Jackson and Bonnier,[12] Zavod,[13] and many others, is perhaps the most popular method in use today. In this technique the piriform sinuses, larynx, trachea, and bronchi are anesthetized in the usual manner by spray or a cotton-tip applicator, followed by instillation through a laryngeal cannula of the anesthetic solution into and through the larynx and by dissemination of the anesthesia chiefly by cough. After anesthesia, a catheter, about No. 16 F., is then introduced through the mouth, pharynx, and larynx into the trachea. As the larynx is observed by a laryngeal mirror, the catheter is directed through the larynx by means of a laryngeal forceps or threaded over a stylet, which is withdrawn when the catheter passes into the larynx. More of the anesthesia can then be introduced into the trachea and bronchi directly through the catheter. This is followed by the injection of the contrast medium through the catheter and then positioning the patient. This method, too, has many modifications. Baker,[14] in 1941, advocated the use of a general anesthetic and instilled the medium through an endotracheal tube. Way and James,[15] in 1950, advocated the same method, except that they had a catheter incorporated in the side of the endotracheal tube to convey the contrast medium. Farinas,[16] in 1947, used an atomization technique in which he also sprayed the contrast medium through the catheter placed in the trachea. Nordenström [17] probably has the most complicated modification of this particular technique. He has two small balloons connected by a catheter to a third

larger balloon. Between the two smaller balloons is the opening of a second catheter. He passes the catheter into one main bronchus, inflates the two smaller balloons by pressure on the large one. This closes the bronchus supposedly above and below the lingular orifice if on the left and the upper lobe orifice if on the right. Then he injects the contrast medium through the second catheter, and since all routes are closed except those into the upper bronchi mentioned, these are filled. He then deflates the smaller balloons, allowing the medium to flow by gravity into the lower lobe bronchi.

The subglottic, or intercricoid, method enjoys the least popularity of the five techniques. The technique in this method is to first anesthetize the skin over the cricothyroid membrane by subcutaneous injection of procaine amide hydrochloride or procaine hydrochloride (Novocain). A needle, usually No. 18 F. or larger, is passed through the skin and between the lower border of the thyroid cartilage and upper border of the cricoid cartilage. This passes into the subglottic area of the lumen of the larynx. Through this is then injected, first, the local surface anesthetic and then the contrast medium, both by gravity. Then the patient is positioned as desired, to fill the various bronchi with the medium. This technique is favored to a large extent by European workers. Hart,[18] in 1942, favored its use, and Field,[19] in the same year, favored its use in children, using nitrous oxide and ether as a general anesthetic to facilitate insertion of the needle, then allowing the patient to react before instilling the contrast medium.

The bronchoscopic method of introduction of the contrast medium into the tracheobronchial tree is perhaps the least used of all the methods. Its technique comprises simply the introduction, directly through the bronchoscope, of the medium into the bronchi or segment desired. It is used chiefly to fill a certain segment desired (Fig. 1) because of inability to outline this particular segment by other means. It is also resorted to when a refractory patient may make the other methods impossible. This is easily understandable when one works in a psychiatric hospital, where any kind of intelligent cooperation is nil. The bronchoscopic method is also used largely in small children, with whom cooperation is also difficult. In spite of the recommendations of certain workers, such as Miller and his associates,[20] many others find a general anesthetic and bronchoscopy necessary for a satisfactory bronchogram. Miller and his associates [20] recommend a solution of aerosol tetracaine anesthesia as a local exclusively in children. They state that with understanding and patience a child can be trained to give his own anesthetic and cooperate in such a manner that the iodized oil can be instilled with ease and a minimum of effort and time. Others, such as McReynolds and Shelton,[21] use a general anesthetic for their bronchographic studies. Baker [14] and Way and James [15] intubate their child patients under general anesthesia and introduce the iodized oil directly through the endotracheal tube. Although the report by Miller and his associates [20] is highly commendable, it is difficult to understand how a child of 2 or 3 years can be made to cooperate even on some of the simplest procedures. Field [19] has used the intercricoid method on children, with some success. It is generally believed, however, that the best all-around average results are obtained in children by the use of a general anesthesia and the bronchoscope.

In making an evaluation of any procedure or technique, one must weigh the advantages against the disadvantages. Often some worker may possess a particular

maneuver, which, to another, may be very difficult. Thus, in the one operator's hands that particular technique is a disadvantage, while with the other it is a distinct advantage. Then, there is always that constant variable—the patient. One type may tolerate one procedure far better than another, but it is impossible before the start of any technique to determine which is the best in this respect. It is with these factors in mind that an attempt is made to evaluate these methods by means of two major criteria: first, the recommendations of writers in the literature, and, second, by personal experience. It is from personal experience that another modification of bronchographic technique is presented.

The advantages of the supraglottic, or laryngeal, technique are primarily that of the patient's comfort. No catheter, tube, or other uncomfortable instrument is present in the patient's mouth and throat during the procedure. The disadvantages

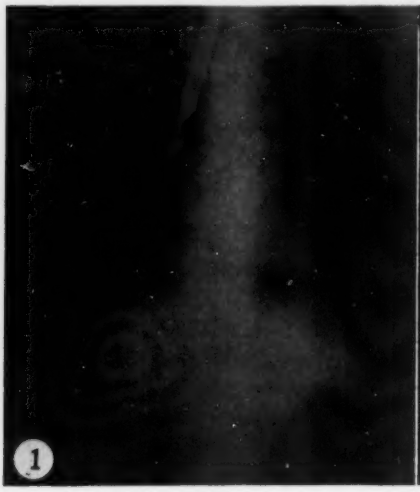

Fig. 1.—Bronchoscopy, with contrast medium filling the anterior division of the right lower lobe.

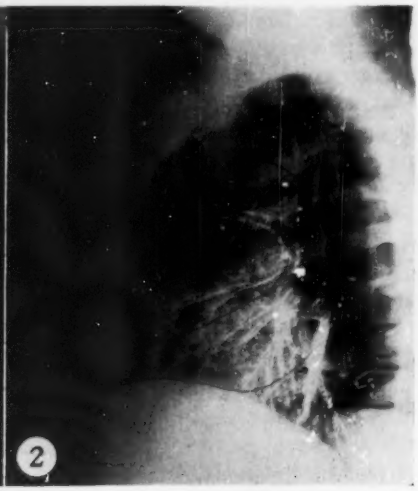

Fig. 2.—Iodized oil swallowed and visualized in the lower esophagus.

seem to far outweigh the advantages, however. First, the patient may easily swallow not only the anesthetic agent but the contrast medium as well (Fig. 2). This would increase the danger of a cocaine reaction, since the cocaine is directly absorbed from the stomach. Second, the anesthetic agent permeates to the peripheral bronchi only after repeated instillations, because of the extremely sensitive gag-and-cough reflex of some patients, so as to prevent the local anesthetic from reaching a point where the cough will spread the solution. Third, because the medium is introduced by gravity, the basilar segments must, of necessity, be filled first. Sometimes it is very difficult to get the contrast medium to flow back to the upper lobe bronchi by positioning the patient. The instillation of too much contrast medium will result in alveolar spread and possible lipoid granulations, pneumonia, etc., and possible harm to the patient. Storrs, McDonald, and Good,[22] Rabinovitch and Lederer,[23]

Wright,[24] and Brody [25] report on the resultant dangers of alveolar filling with iodized oil. The use of a water-soluble contrast medium in an excessive amount may result in an allergic reaction and severe bronchospasm.

The nasal method is probably the least traumatic to the patient of all the techniques. If the operator does not use a catheter by passing it at least into the trachea (Schmidt [8]), this method has exactly the same advantages and disadvantages of the supraglottic method.

The transglottic method, in comparison with the first two, is relatively traumatic. Some patients have a very difficult time retaining a catheter in their mouth and pharynx, and, in spite of local anesthesia, there is frequent gagging and coughing. Because of the presence and feeling he has of a catheter on his tongue and in his mouth, a patient may have a copious salivation, which interferes at times with the progress of the bronchogram procedure itself. The transglottic method does have the distinct advantage of being able to place the local anesthetic and contrast medium definitely below the larynx and into the tracheobronchial tree.

The subglottic method has only one dubious advantage over the others, and that is the fact that the anesthetic and medium are placed directly into the subglottic region itself. The disadvantages, however, are great in number. Among the chief ones is the danger of injecting the needle into some nerve, blood vessel, or vital structure or even of perforating the posterior wall of the subglottic space. Subcutaneous emphysema, progressive mediastinal emphysema, and secondary cellulitis are added dangers. Combined with these are the added discomforts of postural gravity in filling the segments desired and the postoperative pain from the injection. It can easily be understood why this particular technique is not used widely in this country.

The bronchoscopic method has all the disadvantages of trauma, both physical and psychological. It also has the disadvantages of lack of movement of the patient, since positional placing of the patient is impossible with a bronchoscope inserted. Bronchoscopy is not without its dangers, chief among which is alveolar fillng, and if too rapid injection is made, there is a possibility of alveolar rupture, especially in children (Fig. 3). It does have the great advantage of being able to fill one particular bronchus. As has already been mentioned, bronchoscopy for bronchographic study can be used in cases of failure by other methods, in obstreperous patients, and in children.

A discussion of bronchography would not be complete without an evaluation of the contrast media. These fall into two classes: iodized oil or chloriodized oil and water-soluble contrast media containing iodopyracet, sold under the trade names Ioduron B, Umbradil, Diodone Visquese, Methocel-Diodrast, and Dionosil.

To date, iodized oil and chloriodized oil seem to have been the most widely used and are the least toxic of any contrast media. Iodized oil has the advantage of being a free-flowing oil, which gives a relatively sharp contrast to the bronchi by x-ray. It is systemically nontoxic, except to persons with a sensitivity to iodine, which, fortunately, is very rare. Locally it causes no reaction to the mucous membranes, and when at body temperature, iodized oil often cannot be sensed by the patient to be in contact with his mucous membranes. It is not without its disadvantages, however. At times its viscosity is too great to allow it to flow past a portion of

mucus in a small bronchus, giving the illusion in x-ray of an obstruction in that bronchus. Because iodized oil is not miscible with the secretions, the production of an excessive secretion of mucus in the tracheobronchial tree might seriously hamper the diagnostic interpretation of the roentgenologist. Another objection to its use is the fact that it is absorbed slowly from the lungs, requiring several weeks to be removed (Fig. 4). This may interfere with any diagnostic follow-up.

Several cases of lipoid pneumonia and of lipoid granuloma of the lung have been reported following the use of the iodized oil. Storrs and his co-workers,[22] in 1949, Rabinovitch and Lederer,[23] in 1934, Wright,[24] in 1935, and Brody,[25] in 1943, report cases of lipoid degeneration following bronchograms in which iodized oil was used. However, Miller and associates [10] in their study claim that postural

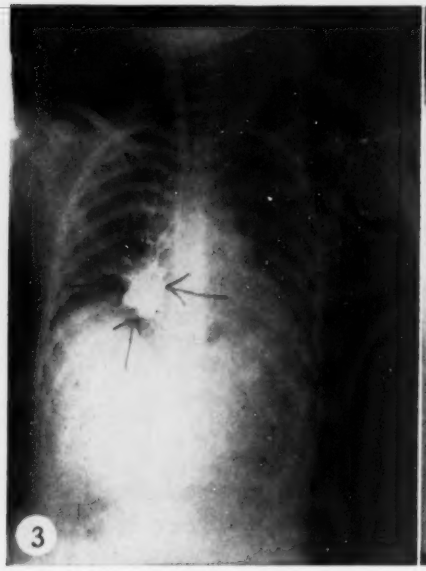

Fig. 3.—Alveolar rupture in child following instillation of iodized oil by bronchoscopy.

Fig. 4.—Alveolar retention of iodized oil six weeks after bronchogram.

drainage immediately, while the patient is still on the x-ray table, reduces the possibility of alveolar extension and subsequent lipoid degeneration to almost nil. A further possible improvement so as to introduce a minimal amount of oil into the tracheobronchial tree is that of Farinas.[16] He atomizes the iodized oil, using a 20% concentration instead of 40%, directly through a catheter into the bronchi. This would seem to tend to decrease the possibility not only of overloading the iodine sensitivity of the patient but also of the alveolar absorption.

In the past few years, the use of a water-soluble contrast medium has come into popularity. Many investigators have reported its use, some of whom have been Morales,[26] Lenzi,[27] and Nordenström [17] in Europe and Norris and Stauffer,[28] Peck,[29] Rogers and Weens,[30] and Salzman [31] in the United States. The European investigators seem to have more enthusiasm for its use than do the Americans. Of

the various water-soluble contrast media available, all have the same physiological activity, but they do differ in their chemical composition and action. They all have as their basic contrast medium iodopyracet (Diodrast). This medium has several advantages over iodized oil. First, it is absorbed rapidly from the lung, and, in studies by Lenzi [27] and others, it has been shown to be eliminated on an average of 35 to 45 minutes. None of the dye can be shown in 24 hours. This naturally eliminates the possibility of bronchial obstruction, alveolar retention, or pneumonia from retention. It also makes feasible a quick follow-up study of the lung fields, since there is no opaque medium to interfere with the study. The water-soluble solution mixes well with bronchial secretions. This allows it to spread rapidly and confluently to the peripheral bronchi. There are disadvantages in using this media, too, however. The first of these may be the rapid absorption, with the result that adequate x-rays may not be taken in sufficient time before partial absorption takes place. The contrast on the x-ray is not as heavy or as sharp as with iodized oil. Practically all the investigators who have used this medium state that a more meticulous anesthesia is needed to control the tendency to cough. Concomitantly, a greater quantity of local anesthetic is needed, with a proportionately greater danger of cocaine reaction. Peck states in his study that the reason for the greater tendency to cough is the fact that the water-soluble medium creates a bronchospasm. This bronchospasm, he feels, may be due to an allergic reaction, since, in his report, he cites two deaths immediately following bronchography. The pathologist felt after postmortem that both deaths were due to anaphylactic shock. Complete and final studies are not, as yet, available on the latent tissue effect of this dye. It is believed to give a latent reticular and fibrotic reaction. In a study Peck and his associates [29] made a comparison of the satisfactory and unsatisfactory bronchograms made with both iodized oil and an aqueous solution of 50% iodopyracet and 1.75% methylcellulose (Methocel-Diodrast), which were the media used. They found that approximately one-third of the patients on whom the Methocel-Diodrast was used had unsatisfactory bronchograms. This was chiefly because of the difficulty to suppress the cough. This compares with the 15% unsatisfactory studies made with iodized oil. The study of Rogers and Weens [30] concurs with this finding. In their series, they obtained unsatisfactory results in 6 out of 16 patients studied. They also feel that, because of the larger quantity of anesthesia needed to suppress the cough, a bilateral bronchogram should not be attempted. Others, however, report better results. Salzman and his co-workers [31] feel definitely that the water-soluble medium is more satisfactory than iodized oil. Lenzi [27] and Morales [26] also report very favorably on its use, although the tendency to bronchospasm is stressed.

Bronchography, in itself, is not primarily concerned with the detailed anatomical structure of the tracheobronchial tree. However, a discussion on the subject of bronchography would not be complete unless some mention was made of the structures which are being studied. The otolaryngologist does not primarily concern himself with reading the bronchograms, but a knowledge of the anatomy involved leads to a much better ability to fill the bronchus or segment involved, thus expediting a more accurate diagnosis of the pathology present.

In order to recognize and understand the bronchus concerned, a readily understandable name should be applied. No universal and standard system of nomenclature has been adopted, although many have been presented. As far back as 1922

Sicard presented one, then Bethune in 1924, Davis in 1929, Molten in 1935, and many others. In 1941 Adams and Davenport [32] suggested the following bronchial nomenclature:

Lobe	Division	Segment
Left upper	Apical	Anterosuperior
		Posterosuperior
		Lateral
		Anteroinferior
Left lower	Lingular	Anterolateral
		Posteromedial
	Dorsal	Anteromedial
	Basal	Posteromedial
		Anterolateral
		Posterolateral
Right upper		Anterosuperior
		Posterosuperior
		Lateral
Right middle		Anteromedial
		Posterolateral
Right lower	Dorsal	Anteromedial
	Basal	Posteromedial
		Anterolateral
		Posterolateral

In 1943 Jackson and Huber [33] presented a system of nomenclature which seems simpler and anatomically more understandable. Jackson, as a bronchoscopist, and Huber, as an anatomist, joined their knowledge and presented the following system:

Left Lung

Lobes	Segments	
Upper	Upper division	Apical-posterior
		Anterior
	Lingular division	Superior
		Inferior
Lower		Superior
		Anteromedial
		Lateral-basal
		Posterior-basal

Right Lung

Lobes	Segments
Upper	Apical
	Posterior
	Anterior
Middle	Lateral
	Medial
Lower	Superior
	Medial-basal
	Anterior-basal
	Lateral-basal
	Posterior-basal

However, whether a certain subdivision of a bronchus is called by one name or by another is not important. What is important is that the otolaryngologist recognize its presence and be able to outline it adequately.

TECHNIQUE

The technique to be presented is made up of a combination of the nasal and transglottic method. The materials needed are few and uncomplicated. As shown in Figure 5, eight items are used.

1. Soft rubber catheter
2. Short rubber catheter
3. Luer-Lok syringe
4. Laryngeal mirror
5. Gauze flats (4 by 4)
6. Laryngeal forceps
7. Cocaine, 2%
8. Alcohol lamp

Fig. 5.—Tray of equipment for bronchogram.

Insofar as the necessary materials are concerned, the soft rubber catheter is perhaps the most important single item in the list. Figure 5 does not show its curved tip well. However, it is a soft rubber urethral catheter, No. 16, with a curved tip of approximately 1 in. (3 cm.), curving almost to a 90-degree angle from the rest of the catheter. Approximately ½ in. (1 cm.) from the tip, which is slightly bulbous, is the eye of the catheter. From the eye, just past the beginning of the curve, to the olive tip the catheter is solid rubber. This solid rubber composition of the tip lends enough firmness so that it can be directed from the open end in any direction desired, and yet it is soft enough not to cause any injury to the tracheal or bronchial membranes. The flared open end has been cut off, down to the No. 16 lumen of the catheter, and a No. 16 needle, the end of which has been cut off, is inserted into the lumen. The catheter is then secured tightly to the needle by several

wraps of silk thread around the catheter. This makes a secure attachment of the needle to the catheter and leaves the head of the needle so that it may be attached easily by its Luer-Lok connection to the syringe. This facilitates the injection of the local anesthesia and contrast medium by means of the syringe through the catheter. The short rubber tube (*2*) shown in Figure 5 is of such a small diameter that it will fit into the connection of a No. 3 Luer-Lok syringe. The reason for its use is that when the anesthetic is being instilled the short catheter will carry the solution past the anterior portion of the nose and deposit it into the posterior portion in such a manner that it will not drip out of the nose anteriorly. A laryngeal mirror is used, of course, to aid in directing the tip of the catheter through the larynx. The laryngeal forceps, No. 6, is used very infrequently and then only in patients who perhaps gag excessively or in those patients in whom the epiglottis is extremely long and overhangs the larynx in such a manner that direction of the tip by the forceps is necessary.

In this modification, the patient is usually premedicated in the usual manner with a barbiturate, usually 0.05 gm. or, in a large person or in a very nervous patient, 0.1 gm. In an extremely nervous patient, a small amount of morphine or meperidine (Demerol) added to atropine may be given in addition to the barbiturate. The patient is instructed not to eat or drink for at least four hours prior to the time scheduled for the bronchogram. Before the procedure is begun every detail of it is explained to the patient so that he understands what is being done and why. The tongue is held with a 4 by 4 gauze flat, and approximately 2 cc. of 2% cocaine is very slowly injected into the nose, with the head tilted slowly back so that the cocaine drips through the nasal pharynx down into the pharynx and into the epiglottis and larynx. The solution is injected so slowly as to require about five minutes to inject the total amount. The patient is also instructed that if he feels the tendency to swallow to cough instead. This tends to eliminate the swallowing of the cocaine, with its possible danger of absorption from the stomach. After this amount of cocaine has been injected a period of approximately 10 minutes is allowed to elapse, and then 2 cc. more of 2% cocaine is injected in the same manner. The first injection usually anesthetizes the nasal pharynx, pharynx, epiglottis, and the upper portion of the larynx. The second injection usually passes through the larynx and anesthetizes the larynx and upper portion of the trachea. After the passing of the catheter into the upper trachea there is usually some coughing and gagging. However, immediately 2 cc. more of 2% cocaine is injected through the catheter, instilling it directly into the trachea and bronchi. Very rarely is it necessary to inject more than a total of 6 cc. This falls well under the limit of possible cocaine absorption and intoxication for an adult patient. The Luer-Lok end of the catheter is then taped to the side of the face, and the patient is taken to x-ray, and under the fluoroscope the catheter is directed into the bronchus desired, that is, the lingular branch on the left and the upper or middle branch on the right. This direction is done with the patient lying flat on the x-ray table. The upper lobes, as seen in Figure 6, are filled first. Then more of the contrast medium is instilled, with the patient in a more erect position so that by gravity the lower segments are filled. Approximately 15 cc. of iodized oil is used to outline the entire side of the lung. Only one side is done at one sitting. Because of the lack of absorption, as sometimes occurs (Fig. 4), if it is necessary to make a bilateral study of the lung fields, the other side is done in

about six weeks. As is seen in Figure 7, one entire lung field is completely outlined, and the arrows point to the main bronchi of the right lung and their primary subdivisions. The main bronchi and their segmental branches are seen to be clearly outlined for accurate diagnosis.

A short experiment was made with this bronchographic technique by using the x-ray camera. The x-ray camera is essentially an x-ray machine which contains 100 ft. (30 m.) of rolled 10-in. (25-cm.) wide x-ray film. By means of a timer, pictures may be taken one after the other at any desired time, beginning at one-fiftieth-second intervals. The frequency of exposures can be preset by means of a timer for any desired speed. In my experiments with the camera, I set the first six or eight pictures to be taken at approximately ½-second intervals for perhaps 10 seconds. This was followed by pictures taken at approximately 1-second intervals for another 15 seconds. Some of the x-rays from the roll film are shown in the

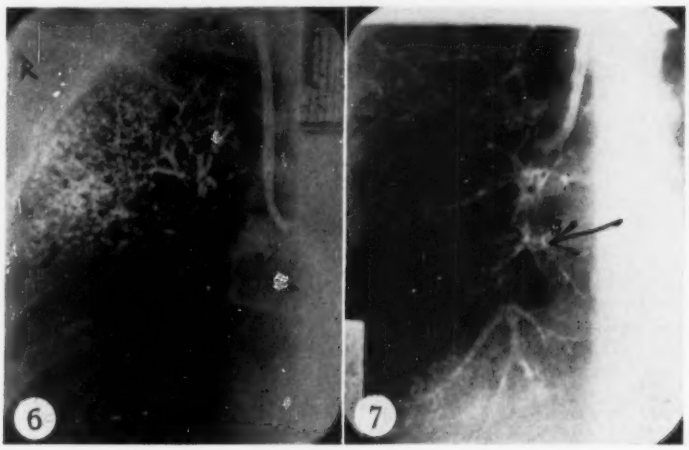

Fig. 6.—Iodized oil in upper lobe bronchi.

Fig. 7.—Bronchogram of the right lung. Arrows point to main bronchial branches and their subdivisions.

serial photographs. They show very nicely the progression of the iodized oil through the various bronchi. However, it is my feeling that the multiplicity of x-rays taken did not add materially to the diagnostic information. I felt that spot films taken directly under the fluoroscope when desired gave just as much information as the many films with the x-ray camera. Consequently, the use of this was discontinued.

I have found by experience that this particular modification has several advantages. First, the curved olive tip of the catheter can be directed very easily by turning the open end. Thus, not only can it be directed easily through the larynx but also into the bronchi desired. Quite frequently the catheter can be directed through the larynx merely by positioning the olive tip in that direction without the use of the laryngeal mirror. Second, adequate anesthesia is easily obtained by the method described. Third, by filling the upper lung fields first, the lower lung fields are more easily filled by gravity. This allows the use of a smaller amount of contrast medium than if one would fill the lower lobe bronchi and then attempt to invert the patient

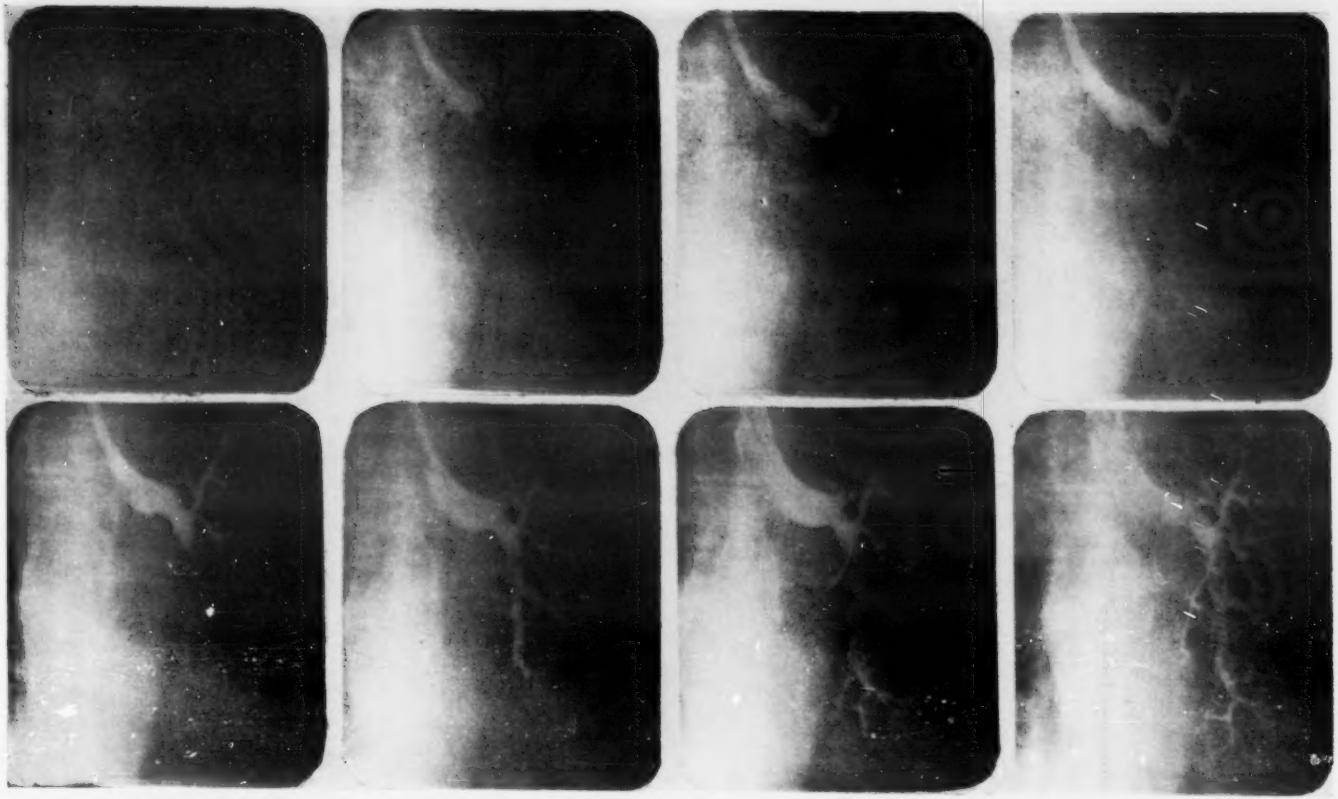

Fig. 8.—A series of x-rays showing the progression of the iodized oil.

in order to fill the upper. Fourth, a minimum of materials and instruments is needed. Fifth, I have found by experience that a 2% cocaine solution gives quite a rapid anesthesia and wears off quickly.

SUMMARY

A review of various methods of bronchoscopic techniques and contrast media is made. An attempt at evaluation of these various methods and media is also submitted. An improved modification of technique is presented.

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SURGICAL ANATOMY OF THE FACIAL NERVE OUTSIDE THE SKULL

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HOUSTON, TEXAS

THE EXTRATEMPORAL portion of the facial nerve has not received the attention it deserves from the average otologist. This phase of neuroanatomy has been left, for the most part, to the plastic surgeon, the neurosurgeon, and even the general surgeon.* Actually, is not the well-trained otologist as well equipped with the entire course of the facial nerve, both within the temporal bone and in the soft tissues of the face and neck? Perhaps there is a reason for the increasing tendency of late to delegate more and more of the field of otolaryngology to the head and neck surgeon, and plastic surgeon, and the neurosurgeon. Certainly some of this undoubtedly stems from the fear of injury to the facial nerve. This paper will attempt to show the role a well-trained and interested otolaryngologist may play with lesions in and about the extratemporal portion of the facial nerve. The reader has probably encountered instances in which the overcautious surgeon has advised "conservatism" in lesions and tumors in the region of the facial nerve, where these conditions would have received prompt and immediate attention had they occurred elsewhere in the body.

Because of this reluctance of a number of surgeons to do any type of work near the facial nerve, it was proposed that a technique or plan be devised whereby the facial nerve could be readily found by the largest number of operators with a minimum of risk to both the patient and the nervous system of the surgeon. Here, as in maxillofacial surgery and plastic surgery of the nose, it was felt that the otolaryngologist had certainly as good a background for this type of work as did men in certain other fields of surgery. Accordingly, the surgical anatomy of the facial nerve was first studied in fetuses of varying sizes and eventually carried out in adult specimens.

Embryologically, it has been said that the parotid gland in its early development lies primarily lateral to the internal carotid artery, the posterior facial vein, and the facial nerve. It has been further noted—and this is important—that the facial nerve is always medial to the principal ducts of the gland, although in its development some portions of the parotid gland completely envelop the nerve. In an effort to prove this statement and because there is surprisingly little in the literature on the early relationship of the facial nerve to the parotid gland, a number of fetuses were studied. Twenty-four fetuses were studied with the aid of the freshman class of the Baylor University College of Medicine. The specimens ranged from 95 to 270 mm. In addition, sections were made in series of fetuses ranging from 30 mm. (8 weeks)

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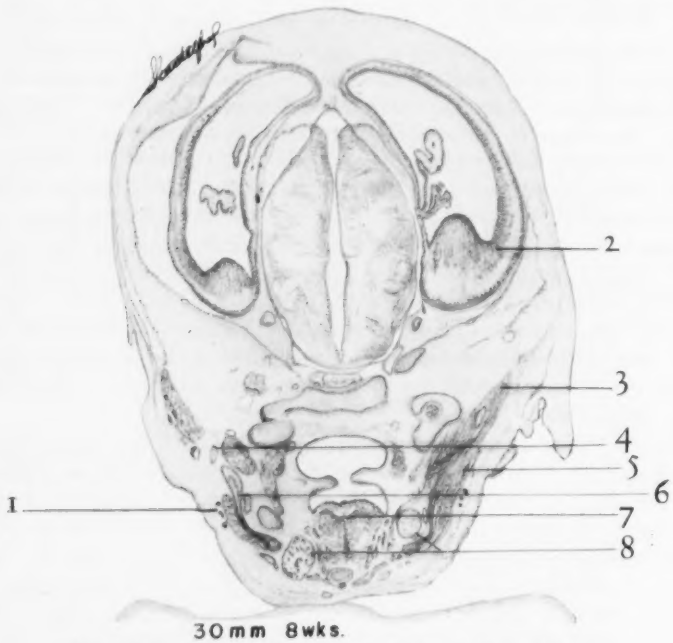
* References 1 to 7.

to 140 mm. (16½ weeks) and up to 200 mm. (21 weeks, or 5¼ months) in an effort to trace the facial nerve from the stylomastoid foramen to its more peripheral branches.

In this study, the very earliest whole specimen studied (95 mm.) showed a well-developed and well-defined facial nerve emerging from the stylomastoid foramen. The nerve was located very close to the surface of the skin, just beneath the subcutaneous tissue, there being little or no mastoid process. It then coursed directly forward to lie directly on the masseter muscle. The main trunk soon branched into several tiny fllaments at the pes anserinus, and these, in turn, supplied the muscles



30 mm 8 wks.

1. *Anlagen of parotid gland*, 2. *Brain*, 3. *Pterygoid m.*,
4. *VII (facial) nerve*, 5. *Masseter m.*, 6. *Mandible*,
7. *Tongue*, 8. *Meckel's cartilage.*

Fig. 1.—The earliest specimen studied. It was seen only in transverse section. Notice the early anlagen of the parotid gland completely away from the facial nerve. The facial nerve lies alone, overlying the masseter muscle.

of facial expression. Only a few tiny glands of the anlagen of the parotid gland were present at this stage of development, and all of these gland bundles were well lateral to the facial nerve trunk. It should be further noted that at this stage of growth the early parotid gland could be gently picked up with a forceps and actually pulled off of the masseter muscle and the facial nerve in a forward direction until it was held by only its long and clearly defined duct. This would leave both the masseter muscle and the facial nerve completely naked and unharmed.

As the older specimens were studied, the facial nerve remained pretty much unchanged. The parotid gland acini became increasingly numerous and approached

the facial nerve trunk and branches from the lateral side. In some of the more developed fetuses, a few of the gland bundles (acini) would penetrate down between the larger branches of the facial nerve trunk. Then as the fetuses approached term, the gland acini which had migrated between the main facial nerve branches would meet at the inner (medial) aspect, thus completely encircling the nerve and its

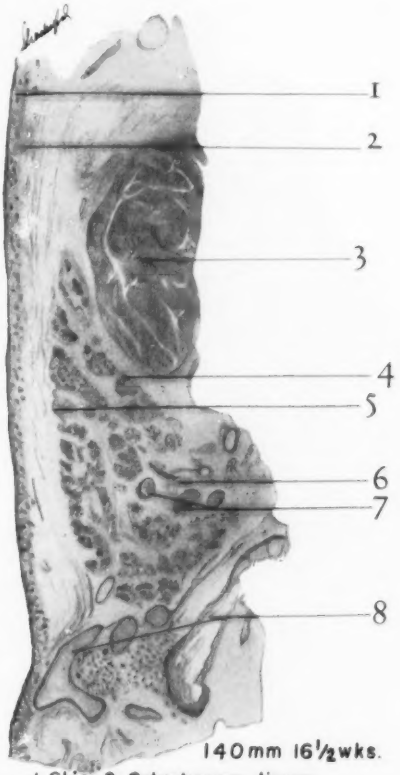


Fig. 2.—Section shows beginning downward migration of anlagen of the parotid gland. Note the deep lying position of the facial nerve.

branches. It must be borne in mind, however, that this is a comparatively late development and that fully four-fifths of the parotid gland is lateral to the facial nerve at birth. Thus, rather than a generalized folding of the parotid gland about the facial nerve, as is sometimes stated, there is actually a migration of the gland acini down between the branches of the facial nerve, finally joining below the nerve. It is probably from some outgrowth of this inner union of the parotid gland that the deep, or inner, prolongation develops.

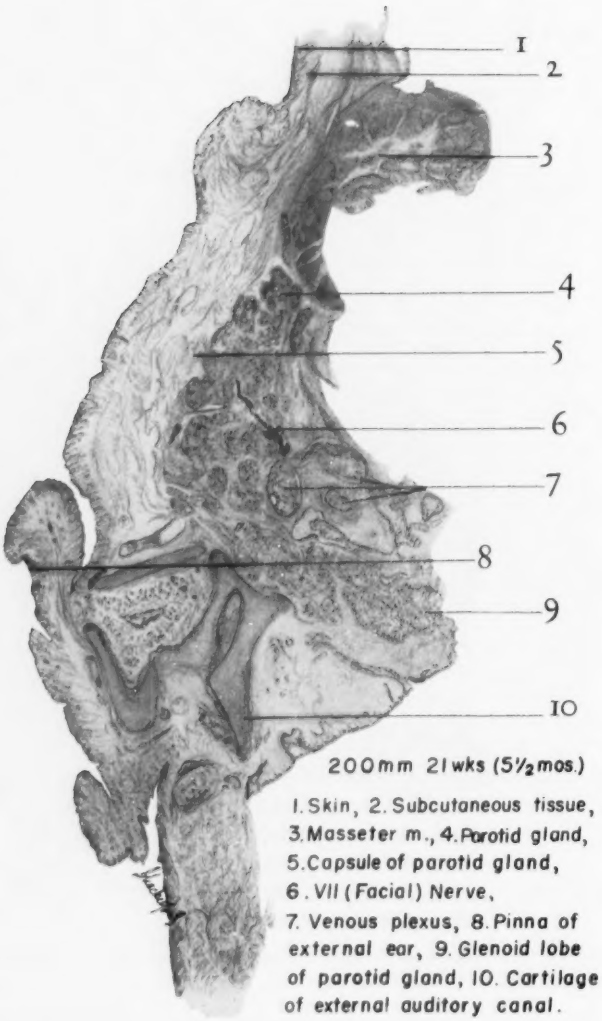


Fig. 3.—More development of the early parotid gland. Its inner prolongation is fairly well established. More of the parotid substance has migrated deep to the facial nerve, but the nerve is still quite deep in the gland and not far removed from the masseter muscle.

During this process of development, the parotid gland and its newly formed acini left considerably more space about the nerve and its branches than was actually necessary, thereby creating small channels through which the nerve could course. This fact is of considerable surgical importance in that it allows for more ready dissection of this nerve and its branches from the parotid gland when the occasion demands.

The study of the parotid gland was next directed to the newborn child and finally to the adult. The principal surgical differences to be borne in mind have to do with the depth of the facial nerve from the skin. In the infant, the nerve, after leaving the stylomastoid foramen, is rather shallow as it enters the capsule of the parotid gland. However, its relationships are proportionally the same as in the adult. A second difference may be found in the size of the deep, or inner, prolongation of the gland, which is usually somewhat longer and more developed in the adult.

In the consideration of the facial nerve in the adult parotid gland, it may be helpful to think of the parotid gland as a sandwich, with the branches of the facial nerve and its trunk as the meat in the sandwich. Actually, from a practical standpoint, this is not far from the case. Such a concept is not new, as this feature has been described before. When one has traced the facial nerve, along with its branches, through the substance of the parotid gland, this outer portion of the gland can be readily removed. Then if the branches of the nerve are gently retracted, the deeper portion, or inner prolongation, can be satisfactorily reached. (In removing the inner portion of the parotid gland, some operators find it helpful to place a gloved finger inside the mouth and push laterally, all the while working against the finger from the outside. These operators feel that this minimizes the danger of entering the oral cavity and aids in freeing the gland from the posterior facial vein and the terminal branches of the external carotid artery.) Then removing the parotid gland in two segments (when this is practicable) makes a difficult procedure somewhat easier and greatly reduces the hazard of injury to the facial nerve.

The most important phase of work in the region of the parotid gland is usually the actual location of the facial nerve, preferably carried out as the initial step. Numerous methods of locating and dissecting the seventh nerve have been employed.† The technique described below is a safe and comparatively simple one and can be employed in every case after some cadaver experience. This method as originally developed was employed by Maxwell and Furstenberg,‡ and I had the opportunity to explore this technique while on the staff at the University Hospital at Ann Arbor, Mich. An incision is made just in front of the tragus of the ear, from the root of the zygoma to the angle of the jaw. Here the incision is carried forward about one finger's breadth below the ramus of the mandible as far as is necessary to obtain adequate exposure. The incision is carried down through skin and subcutaneous tissue to the cartilage bounding the anterior extremity of the external auditory canal. Then with blunt dissection, the cartilage of the external auditory canal is separated from the capsule of the parotid gland as far medially as is possible or until a firm bony resistance is met. This is the base of the styloid process and is encountered at a depth of about 1.5 in. (4 cm.) from the skin incision. It is important to remember to stay high just under the root of the zygoma so that the base of the styloid

† References 3 and 8 to 10.

‡ References 11 to 13.

process is the first important structure to be identified. With finger dissection and palpation, the styloid process can next be identified immediately below its base; a good headlight and a dry field (as in every case of good surgery) greatly facilitate this stage of the operation. With gentle traction on the capsule of the parotid gland anteriorly, the facial nerve is brought into view, emerging from the medial aspect

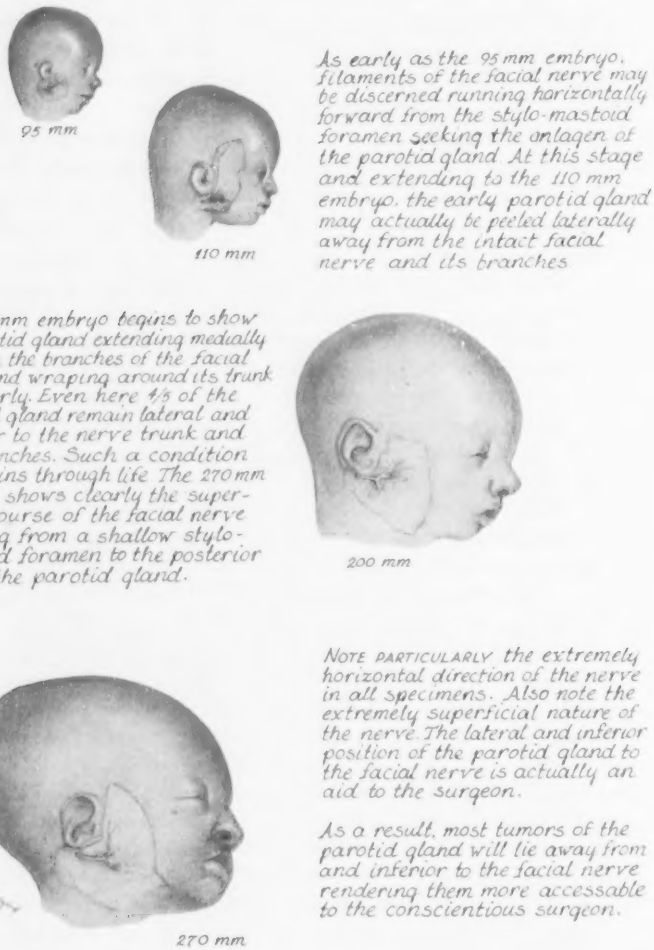

95 mm
110 mm
As early as the 95 mm embryo, filaments of the facial nerve may be discerned running horizontally forward from the stylo-mastoid foramen seeking the anlagen of the parotid gland. At this stage and extending to the 110 mm embryo, the early parotid gland may actually be peeled laterally away from the intact facial nerve and its branches.
The 200 mm embryo begins to show the parotid gland extending medially through the branches of the facial nerve and wraping around its trunk posteriorly. Even here 1/3 of the parotid gland remain lateral and inferior to the nerve trunk and its branches. Such a condition maintains through life. The 270 mm embryo shows clearly the superficial course of the facial nerve running from a shallow stylo-mastoid foramen to the posterior 1/3 of the parotid gland.
200 mm
NOTE PARTICULARLY the extremely horizontal direction of the nerve in all specimens. Also note the extremely superficial nature of the nerve. The lateral and inferior position of the parotid gland to the facial nerve is actually an aid to the surgeon.
As a result, most tumors of the parotid gland will lie away from and inferior to the facial nerve rendering them more accessable to the conscientious surgeon.
270 mm

Fig. 4.—Development of facial nerve in 95, 110, 200, and 270 mm. human embryos.

of the styloid process and coursing sharply upward and laterally to immediately enter the capsule of the parotid gland. The nerve is usually heavily invested in fascia and accompanied by the stylomastoid artery that may prove troublesome if severed.

It is most helpful in this procedure to employ faradic stimulation in identifying the facial nerve. Once the nerve trunk is located in this area, it takes just a moment

to trace its course through the parotid gland to the pes anserinus. From here, the major and even the minor branches can be traced as far peripherally as is expedient for the case at hand. Any surgeon doing much work in the region of the parotid gland should be conversant with the value of electrical stimulation in identifying the nerve trunk and its branches.

A word about using the faradic nerve tester in working on the facial nerve may not be out of order. I employ a specially built machine which can deliver a maximum of either 5 or 50 volts, depending on the state of the nerve itself. At the risk of pointing out the obvious, it should be stated that only that amount of voltage required to just give a twitch in the face when the stimulating electrode is directly in the nerve trunk in a dry field is used. Thus spread of current is reduced, and the facial nerve can be very accurately located and followed.[14]

Any discussion of the extratemporal portion of the facial nerve would be incomplete without some mention of nerve suture. Sir Charles Ballance and

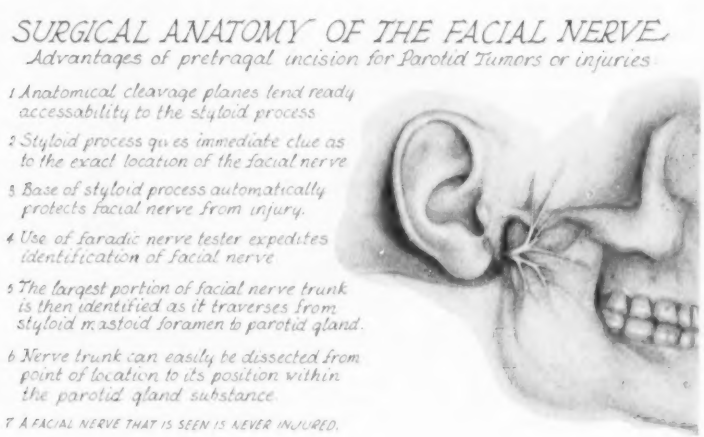

SURGICAL ANATOMY OF THE FACIAL NERVE.
Advantages of pretragal incision for Parotid Tumors or injuries
1 Anatomical cleavage planes lend ready accessability to the styloid process
2 Styloid process gives immediate clue as to the exact location of the facial nerve
3 Base of styloid process automatically protects facial nerve from injury.
4 Use of faradic nerve tester expedites identification of facial nerve
5 The largest portion of facial nerve trunk is then identified as it traverses from styloid mastoid foramen to parotid gland.
6 Nerve trunk can easily be dissected from point of location to its position within the parotid gland substance.
7 A FACIAL NERVE THAT IS SEEN IS NEVER INJURED.

Figure 5.

Dr. Arthur Duel[15] had become dissatisfied with the results of anastomosis operations for the relief of facial paralysis. In 1930, after a series of brilliant animal experimentations, they concluded that facial paralysis, especially that involving injury within the temporal bone, should be treated by autogenous nerve grafts. Previously, Bunnell,[16] in 1927, and Martin,[17] in 1931, had tried to develop this idea, but the real impetus for nerve grafting followed the work of Ballance and Duel. This has repeatedly been confirmed by others.§ The great value of nerve grafting is that it allows for a more nearly normal return of facial muscle movement and associated emotional expression. There are none of the "mass movements" and varying deformities that follow substitution anastomosis of the 11th and 12th cranial nerves. Recent workers have shown the very excellent results of nerve grafting in the extratemporal portion of the facial nerve using preserved nerve grafts, the anterior femoral cutaneous nerve of the thigh, and the greater postauricular nerve.

§ References 18 to 21.

When an injury or a penetrating wound of the face and neck results in immediate facial paralysis, nothing can be gained by "watchful waiting." In fact, watchful waiting should very likely be called procrastination. Immediate exploration, identification of the severed nerve ends and suture, or the use of a graft, if needed, is now better done before infection and a dense scar have rendered the task difficult, if not impossible. If the nerve is found damaged, the injured portion is removed with sharp scissors or a razor blade and the freshened ends approximated with 000000 black nonabsorbable (silk) sutures. Magnification helps direct the suture. An attempt is made to secure the nerve ends by passing the suture through the neural sheath. If considerable substance of the nerve has been lost, a nerve graft (anterior femoral cutaneous or greater postauricular) may be used. Some authors have been using a fibrin-clot suture for both intratemporal repair and repair in the soft tissues of the face. A small plastic cup is affixed to the two nerve ends to be

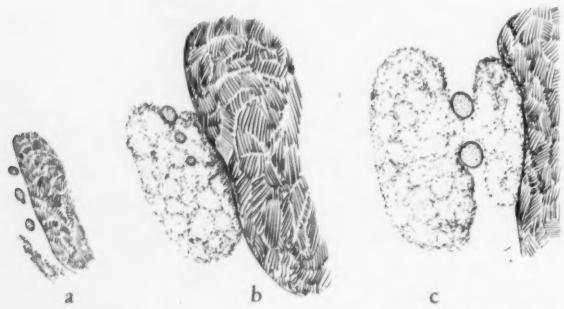


Fig. 6.—Schematic sketch to demonstrate the sandwich effect of the branches of the facial nerve within the parotid gland. (*a*) Very early section showing facial nerve branches lying on masseter muscle, with anlagen of parotid gland beginning to overlie nerve. (*b*) Parotid gland beginning to migrate through branches of facial nerve to form a deeper portion of masseter muscle. (*c*) Mature parotid partially divided into an inner and outer portion by facial nerve and its branches.

joined and these ends held in close approximation. This cup holds the serum about the nerve ends until it forms a firm clot. Such a clot is quite strong and avoids the trauma of suture material. Its proponents claim excellent results and less synkinesia than by other methods. Sullivan [29] advocates the fibrin-clot suture. Tarlov [22] has an excellent manual on this technique. ‖

Unfortunately, some patients are not seen until several weeks or months after the facial paralysis has developed. At this time the reaction of degeneration is complete, there being no faradic response. Of course, if the galvanic response is also gone, there can be no hope for nerve regeneration, as the end-plates of the muscles have become fibrotic. If, however, the galvanic response is still active, the muscle bundles are still viable and capable of receiving nerve fibers. The big question is whether the nerve has begun to regenerate or whether there has been complete severence of the nerve trunk. This is where electromyography may prove to be of real value. The reaction of degeneration gives no information about the

‖ References 23 to 25.

possibility of regeneration of the nerve and reinnervation of the muscles; actually, there may be good functional recovery while there is still no faradic response, even when tested under an anesthetic.[26]

Recent advances in electromyography have held some promise of helping to eliminate this discrepancy. ¶ By the use of high-grade valve amplifiers, fluctuating potentials can be translated into sound in a loud speaker or projected on the screen of a cathode-ray oscillograph (and photographed if desired). Needle electrodes are used, which are inserted into the substance of the muscle to be tested so that samples are obtained of the electrical charges. No electrical impulse is detected under resting conditions of a normal muscle, but on voluntary contraction all muscle fibers of a given motor unit (a unit is supplied by one motor nerve fiber) contract simultaneously, producing an electrical discharge, which, on amplification, gives a popping sound to the loud speaker and a discrete diphasic wave on the screen. Discharges from different motor units are not synchronous, so that when integrated, they appear as an irregular rumble on the loud speaker. It has been found more practical to rely on sound, as this makes detection of small differences in duration and frequency easier than by vision on the oscillograph. With increased voluntary effort, the sounds produced by these motor unit action potentials will be sustained. If this is not obtained, one must suspect inactivity by a large proportion of the motor units. In complete axonal interruption of the facial nerve, there is no recordable activity at rest or on attempted movement for the first 12 days after injury. Then about the 12th day, a rhythmic activity called fibrillation occurs. This has a characteristic quality on the loud speaker and small rhythmic spikes on the screen. Fibrillation is a manifestation of the autonomous life which is characteristic of denervated muscle. Fibrillation action potentials are therefore obtained as long as any contractile muscle fibers remain. If reinnervation occurs, a muscle which has previously shown vigorous fibrillation becomes silent. Thus total absence of normal motor unit action potentials and the presence of fibrillation action potentials indicate complete degeneration. The finding of both fibrillation and motor unit potentials is evidence of a partial or recovering lesion, and a series of periodic observations should be made at regular intervals to determine the rate of progress. And this fact is noteworthy: Motor unit action potentials may precede all outward signs of recovery by as much as three months.

It should be further stressed that lack of fibrillation action potentials in late cases of facial paralysis is strong evidence of loss of contractile tissue from atrophy and, along with the negative galvanic response, is a contraindication to any operation on the nerve. Also, in late cases, in which a few motor unit action potentials are present without any fibrillation action potentials, this indicates a partial nerve recovery, with loss of contractile tissue in the rest of the muscle motor units. One may therefore state that by a combination of electrical testing with the supervised use of electromyography normal innervation of a paralyzed muscle can be ascertained. Also a partial or complete denervation and minimal reinnervation before any observable return of voluntary or emotional movement can all be shown by the method of examining the spontaneous electrical activity of the facial muscles.

¶ References 27 and 28.

It should be pointed out that the readings in electromyography are never easy to interpret and that it is highly desirable to have one well versed in the technique to be present at all determinations.

It is beyond the scope of this paper to describe the methods of handling cases of long-standing facial paralysis associated with fibrosis of the facial muscles and complete loss of all electrical activity. Suffice it to say, such cases can be handled only by any one of several plastic procedures, usually requiring facial slings and supports to the angle of the mouth, the upper and lower lips, and, in some instances, support to the eyelids as well.

Thus, in conclusion, it is hoped that the interested otological surgeon will not hesitate to perform competent surgery in the region of the facial nerve. I feel strongly that he is certainly as well qualified basically as the various other specialists in this field. The fascinating field of facial nerve surgery should prove a challenge, not a fear, to the younger men beginning this specialty. In 1903 Sir Charles Ballance, in writing of the operative treatment of chronic facial paralysis, summed up the objective: "When a patient desires operative interference for the relief of a deformity, the surgeon should be able to communicate to the patient as accurate a knowledge as possible of the extent of the recovery, partial or complete, as the operation offers."

A plea is made for the well-trained otological surgeon to familiarize himself not only with the minute anatomy of the facial nerve but to deal with surgery in and about the nerve with firmness and resolution. Confidence in his ability will improve technique, results, and operative poise. He will know that if a given procedure is indicated and that if it is well done good results may be expected. And he can help prove that a nerve that is seen is not injured.

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VERTIGO (MÉNIÈRE) FOLLOWING RADICAL MASTOIDECTOMY TREATMENT BY TYMPANIC PLEXECTOMY

Report of Cases

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NEW YORK

THE PURPOSE of this paper is to describe recurring Ménière-like attacks of vertigo in five cases following radical mastoidectomy. The episodes of vertigo persisted from a few months to several years after the radical mastoidectomy. In two of the cases the healing was complete. In three cases there was persistent slight mucoid discharge. In all five cases the vertigo, nausea, and vomiting, etc., ceased after section of the tympanic plexus. The radical mastoid operations were performed by other surgeons for chronic suppuration without labyrinthine involvement. In all five cases taste was absent on the anterior two-thirds of the tongue on the side of the operation because of division of the chorda tympani nerve. The ear not operated on was normal.

The five patients ranged in age from 40 to 53 years and described their vertigo as follows: (1) sudden onset of rotatory vertigo lasting a few minutes to a few hours, with nausea and vomiting aggravated by motion of the head; (2) unsteadiness and feelings of side-to-side motion aggravated by bending down or sitting up, sometimes ending in rotatory vertigo, and (3) suddenly being thrown to the ground by fierce vertigo with vomiting. This description of the vertigo is similar to that described by Ménière[1] in 1861. These patients were in good health and had no evidence of cardiovascular disease, multiple sclerosis, eighth-nerve tumor, syphilis, or drug intoxication.

The tympanic plexus was sectioned in all five cases (the first one four years ago) through a large ear speculum in the already widened external auditory canal, the Zeiss loupe being used. The vertigo ceased promptly after the tympanic plexus was sectioned. The tympanic plexus is situated on the inner tympanic wall; the main trunk is Jacobson's nerve (a branch of the ninth cranial nerve), which bisects the promontory in its passage upward from the tympanic floor to the geniculate ganglion. Many smaller and variable branches intercommunicate and go from Jacobson's nerve to the oval and round windows, Eustachian tube, and carotid plexus. Connections are also made with the petrosal nerves before they reach the geniculate ganglion. Jacobson's nerve and some of its branches lie in open bony grooves on the promontory, but not infrequently they lie in completely closed bony canals. In the latter event, the bony canals must be opened in order to destroy the enclosed nerves.

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TECHNIQUE

The approach is made through a large ear speculum in the external auditory canal, and with a sharp, slightly curved dental chisel the promontory is stripped clean of all covering, thus laying bare the bony promontory. With the same instrument, the bony canals containing the nerves are scraped open and the nerves are destroyed. Epidermization is complete in from two to five weeks. The patient may leave the hospital within 48 hours.

REPORT OF CASES

CASE 1.—E. A., a 40-year-old housewife, in 1931 had a left radical mastoidectomy for chronic suppuration present since childhood. A small amount of mucoid discharge appeared at long intervals. In 1948, because of pain in the ear and postauricular tenderness, the mastoidectomy was revised. A cellular mastoid tip was removed. Shortly after the latter operation the patient began having sudden attacks of severe rotatory vertigo, nausea, vomiting, and falling. Hissing tinnitus appeared. The attacks of vertigo, etc., occurred about twice a month. For seven months before my first examination, the vertiginous attacks recurred two to three times a week.

In March, 1950, the tympanic plexus was destroyed. A small granuloma in the tubal region was exenterated. Since this procedure, the radical cavity has remained dry, the vertigo promptly disappeared, and the tinnitus has diminished so that it is no longer annoying. There has been no recurrence of the Ménière disease in four years.

CASE 2.—H. R., a 38-year-old man, had a chronic discharge from his right ear since childhood. In 1947 he began having severe roaring tinnitus in this ear and attacks of rotatory vertigo, nausea, and vomiting about once a month. In May, 1950, a radical mastoidectomy was performed. Immediately after this operation, the disabling vertigo occurred twice a week. The tinnitus increased also. In August, 1950, the tympanic plexus was destroyed, after which the ear became dry; the vertigo disappeared and has not recurred to date. The tinnitus has remained altogether unabated.

CASE 3.—E. G., a 40-year-old man, in 1948 had a right radical mastoidectomy for chronic suppuration. The cavity has remained healed and dry. Within a few weeks after the operation the patient began to complain of a constant side-to-side motion increased by sudden motion of the head, persistent nausea, a pressure and fullness in the right side of the head, burning on the back of the tongue, and itching deep in the ear. There was no tinnitus.

In August, 1953, the tympanic plexus was destroyed. All the above symptoms disappeared promptly, and in over six months there has been no recurrence.

CASE 4.—H. F., a 53-year-old man, in 1938 had a right radical mastoidectomy for chronic suppuration present since childhood. A slight discharge has persisted. After the operation sudden attacks of severe rotatory vertigo and nausea occurred about once a month, incapacitating him for one to two days each time. In September, 1953, the right tympanic plexus was destroyed. The ear became dry in three weeks. All vertigo and nausea disappeared promptly, and after six months there has been no recurrence.

CASE 5.—M. K., a 48-year-old housewife, in 1928 had a right radical mastoidectomy for chronic suppuration since childhood. The discharge persisted. In 1947 the attacks of vertigo, nausea, and vomiting every three or four weeks began. The mastoid was revised in 1947 and again in 1948, without relief but with tinnitus in the right ear. In September, 1953, the tympanic plexus was destroyed. In three to four weeks the ear became dry and has remained dry. Promptly after the tympanic plexectomy the vertigo, nausea, vomiting, and tinnitus disappeared and have not recurred after six months.

COMMENT

A series of papers * has described the disappearance of vertigo in 50% of 50 cases of Ménière's disease after section of the chorda tympani nerve. The present work reports five cases in which vertigo developed after radical mastoidectomy with

* References 2 to 5.

sacrifice of the chorda tympani. In all these cases the vertigo ceased after section of the tympanic plexus. The clinical results therefore indicate two peripheral components in the production of the vertigo of Ménière's disease. The predominant component is the chorda tympani nerve. In some cases, however, the tympanic plexus is also involved, and in those cases this pathway must also be interrupted to eliminate the vertigo.

Stimulation of the central end of the cut chorda tympani nerve produces [6] the sensory phenomena of vertigo, tinnitus and pain. Therefore this nerve also contains afferent fibers other than taste.† It has been suggested ‡ that the clinical result following section of the chorda tympani may be explained by assuming functional interconnection between the central nucleus of the chorda afferents (presumably the nucleus of the seventh nerve) and the vestibular nucleus. Abnormal activity introduced into the former by afferents from the chorda tympani are thereby assumed to initiate the abnormal activity of the vestibular nucleus, which leads to vertigo. It is now suggested that similar afferents exist in the tympanic plexus and that their nuclear terminations similarly interconnect with the vestibular nucleus. The elimination of the afferents from the chorda in most cases would be sufficient to abolish vertigo, but in those cases in which the tympanic plexus is also an afferent pathway, elimination of the latter would also be needed to abolish the vertigo.

Testing of this hypothesis, which is thus far based solely on clinical data, must await neurophysiological and anatomical studies.

SUMMARY AND CONCLUSION

In five cases reported here vertigo developed following a radical mastoidectomy in which the chorda tympani nerve had also been sacrificed. In all these cases, section of the tympanic plexus abolished the vertigo.

The hypothesis is suggested that the tympanic plexus, as well as the chorda tympani, carries afferent impulses to a sensory nucleus which has functional interconnection with the vestibular nucleus, and the abnormal activity of these afferents causes the vertigo. Division of these afferents is assumed to be responsible for the disappearance of the vertigo.

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† Electrical stimulation of the chorda tympani nerve in over 100 cases has not elicited sensations of taste even though section of the nerve abolishes taste.

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EXTERNAL OTITIS

Clinical Observations on One Hundred Cases with Acrisan Therapy

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MUCH HAS been written during the past 10 years on the problems of external otitis. This interest is attributed to (1) the high incidence of external otitis observed during World War II, (2) the development of bacteriostatic and bactericidal agencies, (3) clinical application of relative sensitivity tests, (4) the changing and often unpredictable behavior of the various strains of organisms, and (5) the concept that both exogenous and endogenous factors contribute much to the course of external otitis.

Otitis externa is an inclusive term given to every form of dermatosis which develops in the external auditory canal. It is either a primary or a secondary mixed infection composed of various Gram-positive bacteria, Gram-negative bacteria, and fungi. It may be acute or chronic, but the dermatologic picture is greatly modified by individual susceptibility, allergic reaction, and environment.[1]

INCIDENCE

There is considerable variation in the incidence of external otitis, depending on geography, temperature, and humidity. It is most prevalent in tropic and subtropic zones. It is a disease of the summer season, particularly in regions where the air is warm and damp. Daggett [2] placed the incidence of desquamating otitis externa among the British military personnel in Malta as 48% of all ear cases. Nelson [3] recorded external otitis among the United States expeditionary forces in the South Pacific as 50 to 70%. Senturia [4] stated it to be 5 to 20% of the outpatient practice among the American soldiers in Randolph Air Field, Texas. Jamieson [5] found it to be 9.3% of the otologic outpatient clinic in Great Britain among 65,000 military personnel. Gill [6] in 1942 placed it at 5 to 40% of all cases encountered in otologic practice in the United States. The wide variation in figures is due to the difference in temperature and humidity. Knight's [7] incidence in Texas was 8% of all new patients in his private practice, and in 1953 Branca [8] in Florida estimated it to be 20 to 30%. No age, sex, or race is spared. Blondes are more susceptible than brunettes.

CLASSIFICATION

Basing his categories upon the clinical manifestations, Senturia [4] classified external otitis into (*a*) acute circumscribed, (*b*) acute desquamating, (*c*) chronic suppurative, and (*d*) chronic eczematoid. The latter included otomycosis, neu-

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rodermatosis, and eczema. In 1951 Senturia [9] enumerated the following conditions as to its possible pathogenesis: (1) malformation of skin glands, including diffuse external otitis and seborrheic dermatitis; (2) infections, bacterial and fungous; (3) neurogenic; (4) allergic; (5) primary irritants; (6) senile changes; (7) endocrine dyscrasia; (8) vitamin dyscrasia, and (9) miscellaneous causes. Most of the recent writers * recognized the following clinical types of external otitis:

1. *Acute Furunculosis.*—This is a painful, localized, circumscribed staphylococcic infection limited to the outer third of the auditory canal, where hair follicles are present in association with sebaceous and ceruminous glands. It develops from scratching the skin of the canal to relieve itching and, at times, as the result of improper instrumentation. It is often observed during the bathing season.

2. *Acute Diffuse Otitis Externa.*—The lesion involves the entire soft tissue of the ear canal. Senturia attributes this condition to hyperkeratosis of the epidermis and plugging of the pilosebaceous follicles, due to repeated and prolonged exposure to heat and moisture; thus the normal protective mechanism is impaired, and the soil is prepared for the implantation of bacteria and fungi. He holds the view that Gram-negative bacilli are not the cause of this condition but that they occur as secondary infecting organisms.

3. *Chronic Suppurative Otitis Externa.*—In this condition there is a heavy gray or green discharge, removal of which reveals a white exudate on the discolored skin. Stewart [16] states that this type of bacterial infection is developed from contaminated fingers which came in contact with the external ear canal, the skin of which has been traumatized by scratching. The organisms shown to be present in the affected ears were Proteus, Pseudomonas aeruginosa (Bacillus pyocyaneus), Escherichia coli, and enterococci, by themselves, together, or in combination with other organisms in 94 of the 126 cases. Of the staphylococcal infections 25 were due to Staph. aureus and 17 due to Staph. albus in this series. This is a different proportion from that of the normal, healthy ear.

4. *Otomycosis.*—Micotic infection is most prevalent in the tropical and subtropical zones, but it may be found in colder climates during the summer months. It is responsible for about 10% of otologic cases in the South.[17] Many believe that its frequency is overestimated.† According to Wolf,[27] at least 53 different species of fungi have been reported to cause otomycosis. The chief fungi are Aspergillus niger and Candida.[20] Singer and his associates [28] assert that in their investigation only three species occurred with greater frequency in the infected ears. These are Candida (excluding albicans), Aspergillus, and Cryptococcus. In many instances Pseudomonas aeruginosa (B. pyocyaneus) and other bacteria flora are associated with fungi. Da Silva [29] considers fungi to be the primary source of infection, but the trend of otologic opinion is to regard Pseudomonas and other Gram-negative organisms as the primary source of infection and relegate fungi to the role of secondary saprophytic invaders, such as occur on normal skin.‡

* References 10 to 15.

† References 18 to 26.

‡ References 18 to 20.

5. *Seborrheic Otitis Externa.*—This is often found in conjunction with seborrhea of the scalp in persons with a seborrheic tendency.

6. *Infectious Eczematous External Otitis.*—Infectious eczematoid dermatitis results from epidermal sensitization to the toxin of organisms which are commonly present in normal skin but, for some unexplained reason, have greatly increased in number or changed in behavior. The offending organisms are usually staphylococci but may be fungi.§ Eczematoid mixed infection of the external canal causes intense itching due to the accumulation of cast-off epithelial debris. Scratching induces a minor skin lesion, which leads to exudation and fissures in the meatal orifice.

ANATOMY AND PHYSIOLOGY

Both Daggett and Collins called attention to the anatomical peculiarity of the anterior meatal recess, which favors a "sump for organisms and moist squami," leading to early recurrence of the disease after an apparent clinical cure. Fabricant and his associate [32] have shown that normally the skin is coated with a mantle of acid. This normal acidity is maintained by (1) cornified surface cells, (2) sweat (with a pH of 5.73 to 6.19), (3) secretions of sebaceous glands, and (4) odoriferous secretions of apocrine glands. Any factor which disturbs this physiology increases alkalinity of the skin surface and paves the way for infection.

MEDICAL PREPARATIONS

Hardly a month passes without a new preparation appearing on the market. A combination is made on the supposition that if one drug is good, two should be better. In the light of experimental investigation, uniformly synergistic or antagonistic drug pairs do not exist.[33] A sensible plan is to use the facilities offered by the clinical laboratory for choice of a suitable drug in each instance after a sensitivity test. Singer and his associates [28] state that the sound therapeutic approach would be to use measures effective primarily in inhibiting the growth of Pseudomonas but also against other Gram-negative bacilli and streptococci. There is universal agreement among otologists that the primary objectives of the therapy are (1) relief of pain and discomfort during the acute stage, (2) cleaning of the external ear canals, (3) elimination of the causative organisms, (4) restoration of normal function, and (5) prevention of recurrences.

Among the numerous preparations, dibromosalicyladelyde (Dalyde),[34] coparaffinate (Iso-Par),‖ and nitrofurazone (Furacin)¶ have been widely publicized and favorably reported. For obvious reasons no single drug has been found to be suitable for all cases. With the advent of modern antibiotics and with a wider application of sensitivity tests, the therapeutic measures for external otitis have been placed on a firmer and more accurate basis. The treatment today is highly individualized. Senturia and Doubly [42] recommended as the antibiotic vehicle glycerin, polyethylene glycol (Carbowax), and carboprop (60% Carbowax 4000 mixed with 40% propylene glycol). Such a preparation impaired no antibacterial action.

§ References 30 and 31.

‖ References 35 to 39.

¶ References 40 and 41.

Sulfamylon is para-(aminoethyl)-benzene sulfonamide hydrochloride, having an acid reaction. It has a broad antibiotic spectrum. Local application of 1 to 5% aqueous solution is effective against Pseudomonas.# Five per cent Sulfamylon combined with 1% streptomycin is effective against bacteria and fungi.* Fowler [47] states that Sulfamylon, with or without streptomycin, seems to be a real advance over other medications. He uses a 5% solution thickened with 1% methylcellulose. Mitchell and his associates [48] found that Pseudomonas was susceptible to Sulfamylon or chloramphenicol (Chloromycetin) or both, but dihydrostreptomycin, streptomycin, and chlortetracycline (Aureomycin) were not too effective.

Streptomycin.—Senturia and his associate [49] employed streptomycin in the treatment of diffuse external otitis. Vaheri and Savolainen [50] found that streptomycin was most effective in their hands. Weichselbaum [51] used streptomycin as a local application for Pseudomonas. Saunders [52] employed one part of dihydrostreptomycin and three parts of boric acid powder.

Oxytetracycline (Terramycin) and Chlortetracycline (Aureomycin).—Basing their findings on sensitivity tests, Singer and his associates [28] stated that sulfadiazine and oxytetracycline showed the highest efficiency against Pseudomonas infection, and oxytetracycline and chlortetracycline against streptococcic dermatitis, in the order named. Wright [53] recorded a favorable result from dusting chlortetracycline in the external meatus after cleaning the canal. Gans [54] and Kotyza [55] had similar experiences with Pseudomonas infection.

Chloramphenicol (Chloromycetin), and Neomycin.—Cornbleet and Schorr [56] recommended chloramphenicol for eczema and pruritus of the ear canal. Falk and Allende [57] found favorable response with neomycin sulfate, 5 mg. per gram, in a hydrous wool fat and white petrolatum base. There was no allergic sensitization to neomycin.

Polymyxin and Bacitracin.—These are reported to be effective against infection due to most strains of Pseudomonas and other Gram-negative bacteria.[58] Graves [59] and Branca [60] used Polysin, which is a preparation of polymyxin and bacitracin, with uniformly good results.

Erythromycin.—Livingood and his associates [61] recorded their experience with 0.5% erythromycin, with and without neomycin, in topical therapy. These included five cases of furunculosis, which gave excellent response, and six cases of external otitis, with only one failure. They state that, of the available antibiotics that are suitable for topical use, they prefer the combination of neomycin sulfate and bacitracin, oxytetracycline, chlortetracycline, and neomycin sulfate. Polymyxin B sulfate is the local treatment of choice only for cutaneous infection due to Pseudomonas organisms.

OFFICE TREATMENT

1. *Furunculosis.*—Treatment of furunculosis depends on the stage of development. Small fractional doses, of 75 to 100 r, of x-rays given every three days relieve the otalgia. At times a single dose aborts the infection. To control severe excruciating pain of the acute infection, one may have to resort to nar-

References 12, 43, and 44.

* References 45 and 46.

cotics. Application of heat, either dry or moist, is soothing. Drugs selected for the treatment of acute furunculosis depend on the sensitivity tests. As a rule, in furunculosis the offending organisms are either pure staphylococci or predominantly staphylococci in a mixed infection. After the boil is broken, the canal is gently dried, and boric acid powder may be blown on. For recurrent furunculosis, staphylotoxoid is recommended.

2. *Acute Diffuse External Otitis.*—When the canal is swollen, a ribbon gauze wick moistened with 3% aluminum subacetate solution is inserted to maintain contact with the entire length of the canal. Ochs [62] adds 2% acetic acid to this solution, with excellent results. This wick is changed daily until the swelling is reduced. Ordinary vinegar, which contains 5% acetic acid, may be diluted with an equal part of sterile water, with which to irrigate the canal, to remove the debris and restore normal acidity. Extreme gentleness is required so as not to traumatize the ear when syringing and drying it. Subsequent treatment depends on the predominant organism and the sensitivity of the patient to the drugs with which he is tested.

3. *Otomycosis.*—Pruritus, stuffiness, and discharge are the triad of symptoms for which the patient seeks medical aid. At times the pain in the ear may overshadow the above symptoms. Adequate sedation and a fractional irradiation are helpful. On the first visit the external canal is freed of accumulated debris. This is done by the application of suction with a fine flexible metal tip. I prefer to irrigate the canal with a warm 1:5,000 solution of mercury bichloride. Some like a half-strength apple-cider vinegar for this purpose. This is followed by 1 oz. (30 cc.) of 95% alcohol in the ear canal, which is kept in for 10 minutes. Then the canal is gently mopped with a cotton applicator, followed by a stream of compressed air.[63] Gill [17] recommends *m*-cresylacetate, marketed under the trade name of Cresatin, to be used as a medical wick. The addition of 1% thymol to *m*-cresylacetate increases its potency.[64] The patient is seen daily during the first week, and the medicated-wick treatment is continued until the canal assumes the normal color and is free from debris and odor. The drugs recommended for the treatment of otomycosis are legion, but they must be both fungicidal and bactericidal. They also must be local analgesics. Here, again, the sensitivity test is a dependable guide in the selection of the suitable drug. At the end of the first week the majority of patients are symptom-free. By the second week the visits can be cut down to two to three days apart, when the patient receives an application of soothing ointment, such as that recommended by Furstenburg. This contains phenol, 0.9 gm., precipitated sulfur, 0.9 gm., salicylic acid, 0.9 gm., and wool fat, 30 gm. There is a great tendency for otomycosis to recur, and the patient should be instructed to return to the physician's office for periodic examinations.

4. *Acute Eczematoid External Otitis.*—A continuous moist compress of Alibour water is applied for two or three days. This is composed of copper sulfate, 1.6 gm., zinc sulfate, 5.6 gm., and camphor water, 240 cc. A tablespoonful to a cup of water for moistening the compress is used. After this, to combat dryness and itching, a soothing ointment is applied. If secondary infection is present, an appropriate antibiotic should be given internally. In acute dermatitis venenata

of the ear, in which both the auricle and the external canal are involved, excellent response is obtained by the application of ice-cold boric-acid compresses for two hours, then one-half hour out of each hour while the patient is awake. The patient should be put on an antihistaminic regimen. At times patch tests may be required to identify offenders. The diet should contain low salt, low carbohydrate, and restricted citrus foods. No soap should be permitted on the ear, and there should be no contacts with allergenic agents. Kuhn [65] recorded that neurodermatitis of the ear responded well to cortisone in two or three days but that it promptly recurred when use of the drug was discontinued. To allay pruritus, I prescribe an ointment which contains menthol, 0.03 gm., phenol, 0.3 gm., and tyrothricin cream (Tyroderm) (Sharp & Dohme), 30 gm.

CLINICAL OBSERVATIONS ON ACRISAN THERAPY

During the past two years my associates and I have carried on a clinical observation on the treatment of external otitis by use of a new preparation submitted by a manufacturer.† Upon their admission to the clinic, patients with external otitis were divided into two groups. The first group received the conventional method of therapy usually given in otologic practice. The results of this investigation by another staff member are to appear later. The second group was treated with the new preparation known as Acrisan. Thus every other patient was assigned to the Acrisan study, regardless of age, sex, race, etiology, stage of the disorder, or prior therapy. According to the manufacturer, the original Acrisan contained the following ingredients in anhydrous propylethylene glycol:

1. Aminoacridine caprylate	0.25%
2. Triethanolamine caprylate	6.0 %
3. Triethanolamine undecylenate	4.0 %
4. Pyrilamine maleate	0.75%
5. Benzyl alcohol	0.50%

Ingredient 1 is said to be a new compound; it is bactericidal for both Gram-positive and Gram-negative organisms. Ingredients 2 and 3 are fungicides; ingredient 4 is an antihistamine, and 5 is a mild local anesthetic. A number of patients complained that the application of Acrisan was too painful. Accordingly, the ingredients 2 and 3 were omitted in the new preparation, and the proportions of the ingredients were altered slightly. The new Acrisan has a pH of 6.6 and contains the following ingredients in anhydrous propylethylene glycol:

Aminoacridine caprylate	0.25%
Pyrilamine maleate	1.0 %
Benzyl alcohol	1.0 %

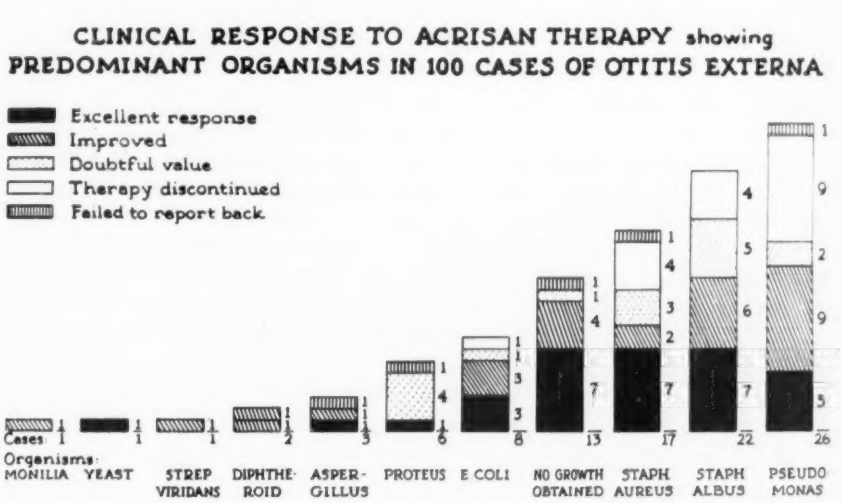
Upon the first visit the patient was informed of our plan of study. From the affected ear a culture was made on a rabbit-blood agar plate. Bacto-Sabouraud dextrose agar slants were implanted when a mycotic infection was suspected. Later in the course of investigation antibiotic sensitivity was conducted on the

† Acrisan was supplied for this study by Andrew A. Recsei, Ph.D., Recsei Laboratories, 47 Tabor Lane, Santa Barbara, Calif.

discs, using several drugs on the market. Acrisan was tested in a similar manner.‡ Many patients lived some distance from the clinic. To these an ounce bottle containing Acrisan was given with instruction to instill the preparation in the affected ear twice daily. Acute cases were usually seen in the clinic every other day, chronic cases once in three to seven days. The Acrisan treatments were

Predominant Organisms Found in Patients with Otitis Externa

Organism, Type	Patient, No.
Pseudomonas	26
Staph. albus	22
Staph. aureus	17
E. coli	8
Proteus	6
Aspergillus	3
Diphtheroids	2
Viridans streptococci	1
Yeast	1
Candida albicans	1
No growth	13



continued until the condition either cleared or was deemed unsuitable. Then some other therapeutic modality was substituted.

The Table indicates the predominant organisms recovered in 40 cases of acute and 60 cases of chronic otitis externa. Those with symptoms of less than one month were classified as acute, and those of longer duration were termed chronic otitis in this study. There was a total of 118 affected ears; 8 of these had

‡ This phase of the investigation was conducted by trained bacteriologists under the supervision of the Department of Bacteriology. Dr. Gordon H. Hadley, Chief of the Clinical Laboratory, and Miss Ruby Dybdahl assisted.

mastoidectomies or were complicated by chronic otorrhea. Since I was assessing the therapeutic potency of Acrisan, no attempt was made to record the etiologic factors.

The presence of Pseudomonas in more than one-fourth of all cases was not surprising. Los Angeles enjoys a year-round mild, balmy climate. Staph. albus is normally found on the skin. Under certain provocations, however, it is capable of acting as a virulent pathogen. Staph. aureus was invariably found in acute furunculosis, either in pure culture or in mixed culture. In 13 cases no growth was obtained. This was probably due to drying or chilling of the swab specimens before the organisms were plated.

The chart graphically indicates the measure of clinical response upon various organisms and the number of patients involved. There were 32 patients whose otitis externa cleared within a week after the initiation of Acrisan therapy. They are indicated in solid black. This is considered an excellent response. There were 29 who showed evidence of improvement by a lessened amount of discharge and a comparative freedom from pain by the end of the second week but whose dermatitis persisted. They are shown by shaded blocks, the line running obliquely from top to right. There were 16 who failed to respond to this form of therapy by the end of three weeks. The preparation was thought to be of doubtful value, and Acrisan treatment was discontinued. These are represented by stippled blocks. In 18 patients the application of Acrisan made the dermatitis actually worse after one or two applications. Several in this group refused to continue with the Acrisan therapy because of intense pain. This was while I was still using the original Acrisan. Other forms of therapy were substituted. The majority of the patients in this group showed acute and chronic exudative types of dermatitis. Had I given a preliminary acidifying medication and reduced the swelling of the canal before Acrisan therapy was begun, the story might have been different. No patient in this group showed sensitivity to this drug. It will be seen from this study that Acrisan is not specific for any one type of organism. It appears to be effective against all forms of organisms in some patients and ineffective in others. There must be other contributing factors to influence the final outcome.

SUMMARY

The available current literature on external otitis is reviewed, and the potency of various medical preparations now on the market is assessed.

Clinical observations with the use of a new preparation known as Acrisan are made on 100 cases of external otitis in Southern California.

Every patient with external otitis should have the benefit of a complete bacteriological study and sensitivity tests to a number of drugs, in addition to the usual physical and laboratory investigations in otologic practice, in order to receive the best available treatment.

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PLASTIC SURGERY OF THE PROMINENT AURICLE

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THE EXTERNAL ear, or auricle, when well shaped and attached to the side of the face at a suitable angle, can be a feature of definite beauty. But when it is too large and lacking in harmonious lines, there is usually at the same time undue prominence, all of which creates an unattractive excrescence and detracts from the appearance of the head from all points of view, whether front, side, or back.

From the standpoint of correction of conspicuous ears, the question of interest is why some persons are apparently unconscious of the size and position of their ears, while to others they may be a source of deep emotional disturbance. Here one must necessarily consider the personality of the person to find the answer, unless there is a specific social or economic loss experienced, as in difficulty in finding employment from the effect of what may in reality be similar to a deformity, even though only the size and shape of the normal ear are involved. In either case, whether the difficulty is emotional or economic, reconstructive surgery is both justifiable and advisable. In children, it is desirable to do a corrective operation before they begin to go to school, so that the difference of their appearance before and after the alteration will not be a matter of comment by other children.

Since the outer ear is of such generally esthetic value, plastic surgeons have devoted considerable attention not only to the reconstruction of ears that are congenitally deformed or distorted by injury but also to the cosmetic correction of ears that are very large and conspicuously prominent. This type of ear was doubtless what Samuel Butler (1612-1689) had in mind when he wrote in "Hudibras" of the "fiddler":

> His swollen ear, hung o'er the strings,
> Was like as souse to chitterlings.

The aptness of this simile can be seen if the abnormal auricle is considered. Prominence is present, as a rule, more or less equally in both ears, though this is not always true. One person, at least, has been apprehended by representatives of the law by reason of having one notably large ear—the only existing mark of identification that was significant.

The commonest cause of the outstanding ear is the developmental lack of a normal antihelix. This lack increases the angle between the back of the ear and the adjacent mastoid surface of the skull, causing a forward projection of the auricle.

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ANATOMY

The normal external ear is made up of a relatively thin layer of elastic fibrocartilage (Fig. 2), which is covered throughout by a layer of skin and subcutaneous tissue, which follows all the irregularities of the contour on both the anterior and posterior surfaces. The subcutaneous layer consists of connective tissue and a small amount of fat, closely attached to the perichondrium. The lobule, which varies greatly in size and shape in different persons, lacks the cartilage framework of the rest of the ear and is made up only of skin and underlying fibrous tissue, in which there is a considerable amount of fat.

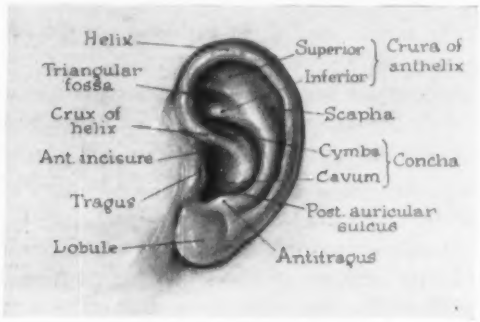

Fig. 1.—Landmarks on the anterior surface of the normal ear.

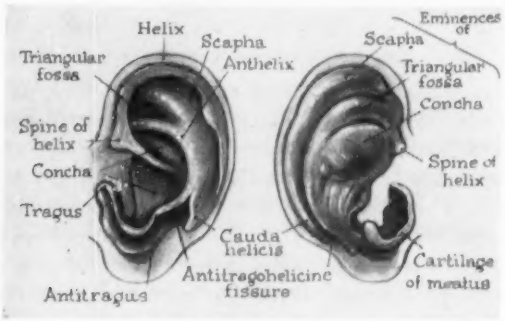

Fig. 2.—Details of the ear cartilage on the anterior and posterior surfaces.

The parts that are concerned chiefly in corrective surgery (Fig. 1) are the helix, or outer rim of the ear; particularly, the antihelix, which lies inward from the helix and follows its curve rather closely; the tragus, a small projection of tissue which extends partly over the exterior meatus; the antitragus, which with the tragus partially closes in the cavity of the concha, the concavity which surrounds the external opening of the auditory canal, and the lobule, the dependent, noncartilaginous portion of the ear.

The ligaments of the ear are (1) the anterior ligaments, which extend between the zygoma, the helix, and the tragus; (2) the superior ligament, extending from

the superior margin of the bony external meatus to the spine of the helix; (3) the posterior ligament, extending from the mastoid process to the eminence of the concha.

The extrinsic muscles of the ear are the anterior, superior, and posterior auricular muscles. There are also six small, poorly developed muscles within the auricle: (1) the great muscle of the helix, on the lateral surface, extending from the spine of the helix to its anterosuperior margin; (2) the minor muscle of the helix, which overlies its crus; (3) a muscle of the tragus, which runs vertically upon its surface; (4) the antitragus, which runs from the antitragus to the cauda of the helix; (5) a transverse muscle, on the medial surface, between the eminences of the concha and the triangular fossa. There may also be two other small muscles, which are seldom considered anatomically.

The arteries of the auricle are the postauricular and the superficial temporal, both of which arise from the external carotid artery.

The veins are the anterior auricular, which joins the temporal vein, and the auricular branches of the postauricular vein, which contribute to the auricular vein.

The lymphatics empty into the anterior, posterior, and inferior auricular lymph nodes.

PHYLOGENY

From the phylogenetic standpoint, the external ear is considered a distinctly mammalian addition to the auditory apparatus. During the stages of evolution when life was confined to water, there was little, if any, auditory need. Vestibular activity was sufficient and was received by the so-called lateral line organs, which in the course of time became the cochlear portion of the mammalian ear. The auricle is considered a vestigial organ by some authorities.

EMBRYOLOGY

There is a considerable difference of opinion concerning the exact mode of development of the human embryonic ear. His was the first to carry on a detailed study of this subject, but later investigators do not entirely agree with his conclusions. It is now generally agreed that at about the 12 to 14 mm. stage in the life of the human embryo, a number of small nodules, or tubercles, appear about the mandibular and hyoid arches, which differ in the various specimens in number and size. The entire auricle, except the tragus, is now considered to be formed from the hyoid arch; it develops gradually on the posterior margin of the first branchial cleft. The tragus alone appears to be derived from the mandibular arch. This finding is supported by the observation that removal of the Gasserian ganglion or the third division of the trigeminal nerve does not produce anesthesia of the auricle, while section of the great auricular nerve produces anesthesia of the entire external ear except the tragus and the anterior portion of the external auditory canal.

PHYSIOLOGY

The external ear has only a limited function in man, in whom it is seldom movable. It does, however, serve to collect vibrations of the air to some degree and to conduct them into the external auditory meatus. In animals which are provided with external ears, the auricle is movable and can be kept directed in a way to locate sound and to increase its volume within the auditory organ.

Much research would be required to discover exactly when outstanding ears were first corrected surgically.

Dieffenbach (1845) appears to be the earliest operator to use surgery to correct protruding ears. His method consisted in the removal of a crescent of skin only, from the back of the auricle and from the corresponding surface of the adjoining cranium; then the ear cartilage was sutured to the cranial periosteum. No cartilage was excised.

DeMartino (1856) has been credited with having been the first to remove both skin and cartilage to reduce outstanding ears. (See Frühwald below.)

Ely (1882) has also been considered to have been the first to remove both skin and cartilage, but the chronology must be considered as well as the fact that his method was similar to that of DeMartino's.

Keen (1890) varied this method by first removing a wedge-shaped piece of skin from the back of the ear, then a similar shaped section of the cartilage, without disturbing the anterior skin.

Monks (1891) used a method for correcting ears according to the consistency of the cartilage. If it was soft and pliable, he removed only an ellipse of skin from the back of the ear; but if the cartilage was stiff, both cartilage and skin were removed.

Joseph (1896) first reported an operation similar to that of Keen but later altered his method somewhat. He made two curved skin incisions—one on the back of the auricle and another over the adjacent mastoid region of the skull. The spindle-shaped area of skin between the two incisions on either side of the postauricular fold was ½ to 1 in. (1 to 2.5 cm.) wide at its greatest diameter. He emphasized that the skin removed should be exactly the right size to bring the ear into the desired position and that the cut margins of the cartilage should meet very closely or even overlap when sutured.

DeSchweinitz and Randall (1899) corrected the deformity in children by attaching the auricle to the skull surface with glue or collodion and then bandaging it firmly until the union was secure. Surgery was reserved for adults and consisted in making similar skin incisions on the back of the ear and over the mastoid to those which are used by many operators today, except that no cartilage was excised.

Morestin (1903) followed Joseph's method closely, with the addition of the caution that the incision through the cartilage should extend nearly through both the upper and lower extremities of the cartilage, where it meets the skull, in order to break its forward spring.

In 1910, Luckett described an operative method that has remained the general pattern in use by many surgeons today. His technique was devised to fit his idea that the outstanding ear is caused, in most instances, by the lack of development of the normal antihelix. His method creates a ridge by incising the cartilage along the curved line where the prominence of the antihelix should be; then the incisions are turned forward by means of sutures so placed that they bring into apposition the posterior surfaces of the cartilages on either side. A crescent of cartilage is usually removed, but if the ear is small, a simple fold of cartilage is sutured to make an anterior ridge. The sutures are set at the required distance from the cut edge of the cartilage, to make an antihelix of the desired prominence. This will depend

upon the size of the ear and the thickness of the cartilage. If the cartilage is very thin and flexible, the sutures can be applied in the same manner as in the small ear, without incising.

During the same year (1910), Ruttin corrected prominent ears by making two parallel, slightly curved incisions: one on the back of the auricle and one on the opposed surface of the mastoid region. He attached a strip of fascia lata to the perichondrium along the posterior border of the helix and then drew it subcutaneously to the mastoid process, where sufficient tension was exerted to bring the auricle into the desired position, and then it was sutured to the periosteum.

Gersuny (1920) varied the general method of correcting prominent ears by turning back a flap of skin from both the auricular and cranial surfaces, based on the mastoid process. Two narrow, vertical strips of the underlying cartilage were removed over the auricle, and the remaining strips were cut at right angles, from which alternate pieces of the cartilage strips were excised. This procedure left small islands of cartilage with spaces between them. The periosteum of the cranial surface was then sutured in turn to each of the islands of auricular cartilage and the skin resutured.

Frühwald (1932) gives DeMartino (1856) credit for having been the first to operate for prominent ears and followed his method. A wedge of tissue is removed with scissors at about the junction of the upper and middle thirds of the helix. The cut is made through the entire thickness of the auricle, with the apex of the wedge extending into the cavity of the concha. The size of the wedge must necessarily be determined by the size of the ear itself. If the ear was so large that simple approximation of the sides of the wound with sutures did not produce the desired effect, a small accessory wedge was removed from either side of the primary one. After careful approximation, the skin was sutured on both surfaces of the ear with a nonabsorbable surgical (fine silk) suture, with care taken that the needles should not be passed through the cartilage. For lesser deformities, a "sickle-shaped" segment of the ear, with the point directed upward, was excised just above the tragus.

Davis and Kitlowski (1937) described a method in general derived from that of Luckett. The ear is held against the head in a normal position, and the upper and lower limits of contact are marked with dye. The line of the proposed reconstruction is indicated by punctures of the auricle 1 cm. apart, each one marked with the dye. The ear cartilage is then incised along this line throughout the length of the antihelix. This point is particularly emphasized as necessary for destroying the spring action of the cartilage (particularly emphasized by Morestin). Both margins of the cartilage are turned forward by passing an absorbable surgical (gut) suture through the perichondrium on one side about 0.5 cm. from the cut border, carrying the needle across the intervening space and through the perichondrium on the other side. Five sutures are used altogether, and all are drawn up at once, then tied.

In 1940, New and Erich modified Davis and Kitlowski's method by introducing the use of mattress sutures as an aid in maintaining the form of the new antihelix. They also removed cartilage from one or both of the superior and inferior crura when the position of the ear required it.

Young (1944) presented a modification of the Davis and Kitlowski operation, by which a new antihelix could be formed by excising the cartilage in such a manner that the scapha could overlap the concha and no sutures would be necessary

in the cartilages. Excision of cartilage was made preferably from the superior crus, although occasionally excision might be necessary in the inferior crus also.

Seltzer (1947) operated by holding the auricle under tension and making two curved incisions—one on the back of the auricle and a similar one on the adjacent surface of the skull—to form an ellipse. The enclosed skin is undermined, and a corresponding area of underlying cartilage is removed. This piece of cartilage should be relatively long, since the desired result will otherwise not be obtained, though the upper and lower rims of the cartilage should not be incised. That would remove the support necessary for maintaining the contour of the ear. After the edges of the cartilage are smoothed off with care, they are sutured with 4-0 absorbable surgical (gut) sutures; the skin sutures are of 6-0 nylon.

Also in 1947, Pierce, Klabunde, and Bergeron used a method for reducing prominent ears by making eight or more incisions through the cartilage. They considered that their method resulted in a more normal appearance of the antihelix, without forming too prominent a ridge on the front surface of the ear. Becker's criticism of this method is that it is suitable only where there is a limited degree of protrusion.

Becker (1949) incised through the skin and perichondrium on the back of the ear corresponding to the area between the scapha and the concha, extending upward to the junction of the ear with the temporal surface of the skull and inferiorly down to the base of the antitragus close to the mastoid region. Both skin and perichondrium are then undermined laterally almost to the auriculomastoid angle and to the beginning rim of the helix. This procedure serves to expose the entire posterior surface of the cartilage. When the ear is then placed against the head, a normal appearing antihelix is seen on the anterior surface of the auricle. This line is marked by piercing the cartilage, and the point where it appears on the cartilage at the back of the ear is marked with methylene blue as an outline for the incision. Two incisions are made through the cartilage, resulting in a diamond-shaped outline. The size of the excision, usually 6 to 9 mm. at its greatest width, must depend upon the amount of cartilage spring that must be overcome. The skin is undermined for a few millimeters on the anterior surface of the auricle. No cartilage is removed from the superior crus. The sulcus corresponding to the inferior crus is incised entirely through; this cut extends into the incision already made in the cartilage of the antihelix and serves to destroy the spring of the inferior crus. Removal of cartilage or cross cutting here is seldom required. Removal of the cauda of the helix may or may not be needed, depending upon the extent of the deformity. When the cartilage is unusually stiff, the superior crus is incised transversely though not entirely through the cartilage. This is done to further weaken the cartilage spring, and it contributes to a roundness of contour. A small, transverse piece of cartilage is taken from the upper end of the superior crus where it joins the helix, to make a complete break in the spring of the helix. The closing mattress sutures of 3 or 4-0 absorbable surgical (gut) sutures are used along the edges of the primary incision in the cartilage. They are tied only tight enough to form the new fold for the antihelix. The excess skin on the back of the ear is removed and the skin margins closed with interrupted nonabsorbable surgical (black silk) sutures.

Brown (1948) incised the cartilage along the line of the proposed new antihelix and made a cartilage fold wider by apposing flat surfaces in the manner of a seam

by sliding one edge of the incision past the other or by drawing the cut edges of the cartilage incision together by sutures so that the anterior surface of the distal margin would be in line with the posterior surface of the proximal. The method otherwise is similar to that in general use.

Barsky (1950) employs a method based upon that of Luckett. He has found that even when the ear is abnormally large as well as oustanding, if it is corrected so that its position is in proper relation to the skull and a normal antihelix is created, the size of the ear is seldom of importace.

Leonardo (1951) employs the simple method of removing both skin and cartilage by the two customary curved incisions on the back of the ear and over the mastoid region of the skull. He introduces the procedure of injecting a few cubic centimeters of a 1% solution of procaine hydrochloride (Novocain) between the anterior perichondrium and the underlying cartilage, to help in dissecting the cartilage from the anterior tissues. This leaves the anterior perichondrium intact when it is dissected from the cartilage. His incisions are made both inferiorly and superiorly so that no cartilage is left connected directly with the skull. This is done to break the spring of the cartilage, so that the ear can be placed against the skull and not bend forward. No internal sutures are used, but for the skin interrupted absorbable surgical (gut) sutures are preferably employed. If the inferior crus of the antihelix is not prominent enough, the posterior perichondrium is cut and the two sides approximated at about 1/16 in. (0.2 cm.) from their edges with nonabsorbable surgical (white silk) sutures. This will produce a ridge similar to the normal inferior crus of the antihelix.

Sarcer (1951) considers that the cause of prominent ears is an abnormal shortness of the anterior auricular ligament attached to an overdeveloped spine of the helix. He excises the spine and ligament through the same incision, above the tragus. The small scar involved soon becomes invisible. With this excision, which allows the ear to fall backward, he also removes a long oval segment of skin behind the ear, as in customary operations.

Ragnell (1952) describes a modification of the Luckett operation. An incision is made on the back of the ear through the skin, roughly parallel to and 1½ cm. from the free margin of the ear. The skin is undermined for a distance of 1 cm. toward the attachment of the ear and outward to the free margin. This includes two-thirds of the auricular cartilage. Great care must be exercised in elevating the skin over the edge of the ear. To avoid this difficulty, the cartilage may be cut through parallel to the margin, leaving a millimeter of cartilage on the under surface of the skin; this makes the undermining of the skin on the front of the ear easier. The undermining on the front of the ear, which is done with small blunt scissors, is carried to a point immediately below the line intended for the new antihelix. The skin is then pulled forward free from the cartilage. The next step is to slit the cartilage into sections 3 to 4 mm. wide; this is done with blunt scissors. The first cut is made forward and upward, the next, backward and downward until the entire fossa of the helix is slit as far as the antihelix line. An incision 1 cm. in length is then made through the skin over the tragus and undermined anteriorly for 1 cm. both upward and downward until the scissors used in the undermining appear at the upper and lower margins of the freed cartilage. A piece of stainless steel, hard-spring, 0.5-mm. dental wire—which is "practically isoelectric" with body tissues—is drawn from the incision at the tragus, through the subcutaneous channels of the ear

margin, and back to the opening on the tragus. The wire loop should be somewhat smaller than the desired size of the auricle. The ends of the wire are controlled with artery forceps. The cartilage segments at either end are wound somewhat spirally around the wire and fastened both to each other and to the wire, with fine sutures passed through the cartilage. These cartilages must be so arranged as to form a suitable fold for the antihelix, especially in the anterior part, so that the relations of the outer parts of the ear will be in proper proportion. The remaining segments of the cartilage are then sutured to each other and to those around the wire

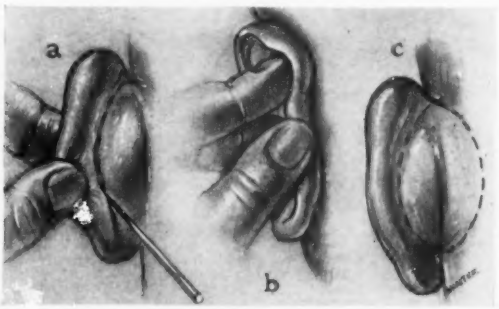

Fig. 3.—(*a*) Line of incision. (*b*) Folding the ear back to determine suitable position. (*c*) Oval area to be excised.

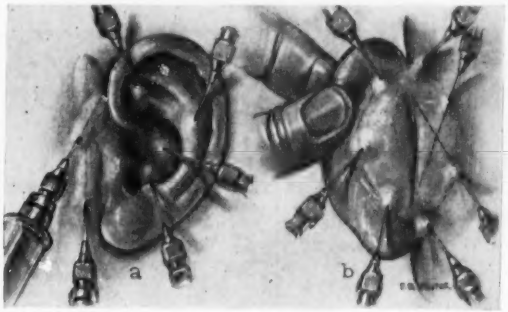

Fig. 4.—Method of cross-fire anesthesia: (*a*) front of ear; (*b*) posterior surface of ear.

in a manner that will resemble lattice work, in which the connective tissue will grow and finally form a new fossa of the helix. The skin which was freed from the greater part of the ear forms a capsule, which is drawn over the cartilage again and fixed with mattress sutures behind the auricle. The steel wire is now bent to the desired size and shape, exerting care that it does not make pressure against the skin, which might cause injury. The ends of the wire are fastened together and buried inside the incision over the tragus and the skin sutured. Cotton wool, which has been soaked in flavin paraffin or some other plastic material, is packed within and behind the auricle so as to produce the desired contour. A period of three months is allowed for the growth and shrinkage of the newly formed connective tissue in the lattice work of the cartilage before the wire is removed. This can be done under local anesthesia.

Gonzalez-Ulloa (1952) describes a method notable for its brevity. Under local anesthesia, the auricle is folded backward to a normal position, and marks are made corresponding to the crura of the normal antihelix. The skin in front of the ear is infiltrated with a 2% solution of procaine hydrochloride-epinephrine, which is also injected through the cartilage to include the skin on the back of the ear. A 5-mm. incision is made midway on the antihelix, through which an elevator is introduced and the skin freed over the region of the back of the cartilage as on the front. The cartilage is then cut with scissors completely through the lines of both crura of the antihelix and its lower extension. The small skin incision is then sutured, and the

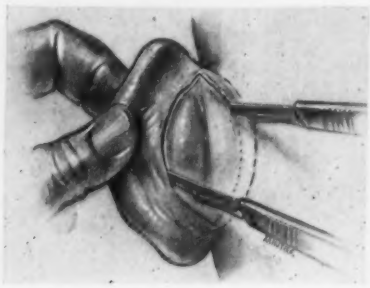

Fig. 5.—A No. 15 Bard-Parker knife cutting through the skin only and following lines marked with the dye. The knife incises over the inner line on the mastoid surface.

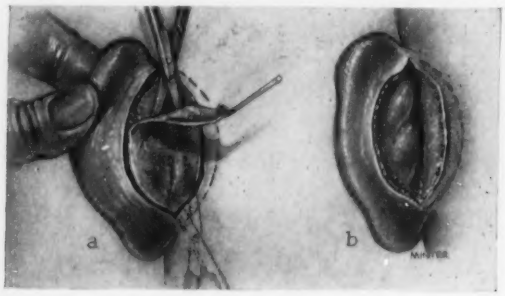

Fig. 6.—(*a*) Undermining the skin from below and above with curved scissors. (*b*) Skin removed, showing denuded area.

auricle is molded to the desired contour, with reduction of the size of the cranio-auricular angle. Filiform, rustless wire is used to transfix the ear in its new position, at points at such a distance from each other that the ear will be held firmly. A pressure bandage is carefully applied without further dressing, and the patient can go on with his normal activities on the same day.

Many plastic operations have been done for the correction of outstanding ears besides those which have been included here, but none of them have appeared to represent changes of importance or newer methods.

I realize that no single method for use in all instances of prominent ears can be adhered to, since there is no common pattern of an auricle but many variations from

the general average anatomical structure, and similar to other facial features, the ears of no two persons are exactly alike. To be generally successful, therefore, any method must be adaptable to the individual condition.

My own present procedure is derived partly from Luckett's method, but with original modifications.

As in all treatment in medicine, the history of the patient should be carefully taken and recorded, and a thorough physical examination is of even greater importance, since any surgery, however minor it may appear, is in fact a major operation for the patient.

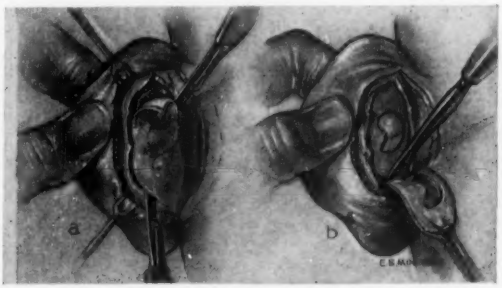

Fig. 7.—(*a*) The ear is held forward with the tension of the thumb and finger as the cartilage is excised. (*b*) Cartilage is removed, with the comma-shaped piece remaining to support the cavum.

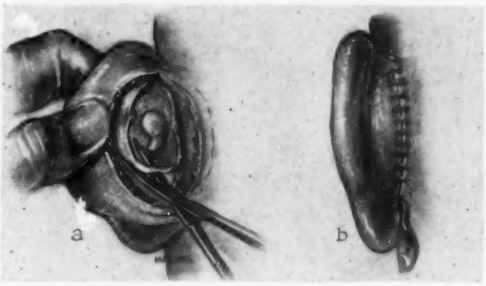

Fig. 8.—(*a*) Trimming the edge of the cartilage with curved pointed scissors, to remove sharpness that might affect the anterior skin. (*b*) Sutures in place and ear in new position.

The laboratory examination should include a Wassermann test; complete blood cell counts with hemoglobin estimation, to rule out possible blood dyscrasias; urinalysis, with particular attention to possible diabetes.

The patient is posed before a mirror, and the most suitable position of the ears determined from the front, back, and side viewpoints. The head is photographed as it appears without ear adjustment, from the same angles. Attention is carefully given to any lack of symmetry between the two ears. A cinematic film is made on all patients.

After all possible examinations are made, the patient should be told quite frankly that final success can neither be guaranteed nor promised. This precaution will avoid any possible later misunderstanding.

When the line for the skin incision is finally determined, it is marked with methylene blue to aid in accuracy of the primary incision. The dye is applied with an applicator and then blotted to prevent it from becoming a smear instead of a sharp line. The ear is then lightly pressed directly back against the head to duplicate the dye line on the mastoid surface (Fig. 3*b*).

The preoperative technique of anesthesia in children is preferably with ether or gas. For adults local anesthesia is preferred, and for this butethamine (Monocaine) hydrochloride, procaine hydrochloride (1%) with epinephrine (1:50,000), or a complete nerve block can be done by cross fire over the entire area (Fig. 4) except

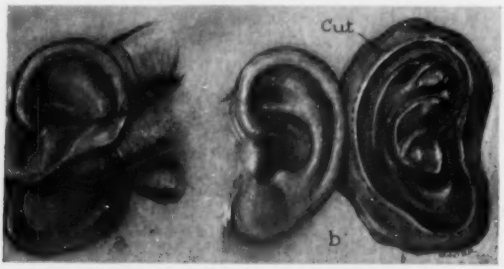

Fig. 9.— (*a*) Applying the small sheet of dental mold, which has been softened to make a cast of the ear anteriorly. (*b*) Appearance of the removed cast and a diagram for trimming.

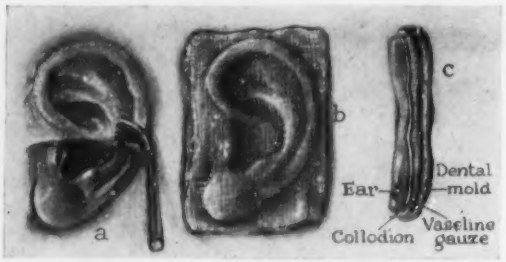

Fig. 10.—(*a*) Painting the front surface of the ear with collodion preparatory to applying the cast after operation. (*b*) Petrolatum (Vaseline) gauze spread over ear. (*c*) Lateral view of ear showing collodion layer, petrolatum gauze, and dental mold applied over all.

the margin of the ear. Although no incision is made on the front of the ear, its subcutaneous injection will aid in separating the skin from the underlying cartilage. Morphine, scopolamine, or a barbiturate, as amobarbital (Amytal) sodium, is administered before the anesthetic.

Sterile cotton is inserted into the external canal; the hair is not shaved in either children or adults but only cut short for a distance of an inch within the hairline so that this line remains clearly visible, to serve as a guide in determining the proper position for the ear. Otherwise, it might not be possible to place the two ears exactly alike, resulting in a monstrosity.

After the field has been thoroughly sterilized, with a No. 15 Bard-Parker blade, the skin is incised very superficially along the dye line on the mastoid surface, and the first complete incision is then made one-third of the distance from this line toward the postauricular fold (Fig. 5). On the back of the auricle, the incision is

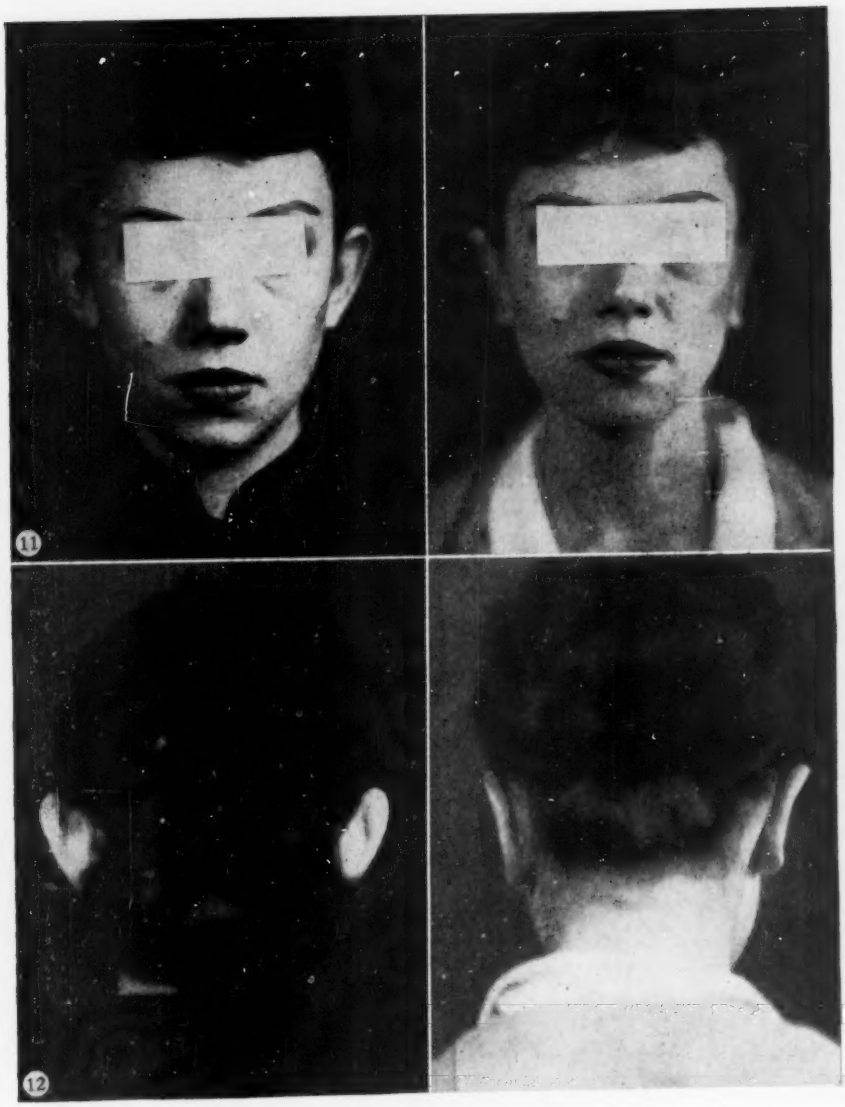

Fig. 11.—Front view of patient before (left) and after (right) operation.
Fig. 12.—Rear view of patient in Figure 11 before (left) and after (right) operation

Fig. 13.—Front view of patient before (left) and after (right) operation.
Fig. 14.—Side view of patient in Figure 13 before (left) and after (right) operation.

made exactly over the dye line and meets the one on the mastoid surface at both extremities, thus forming an oval area of skin and subcutaneous tissue (Fig. 3 *a* to *c*). This area is entirely undermined from above and from below (Fig. 6) with curved scissors. Straight scissors are avoided, since they might easily perforate the anterior skin.

When the skin is completely undermined, a corresponding area of cartilage is removed to break the spring of the ear. To do this, the auricle is held between the finger and thumb, and the ear is drawn outward to create a suitable degree of tension, which not only aids in the exact cutting of the cartilage but also acts to lessen bleeding (Fig. *7a*). In incising the cartilage, one must exercise unusual care not to cut through the skin on the anterior surface. When the cartilage is excised on the back of the auricle, the line of the incision should be along the junction of the ear

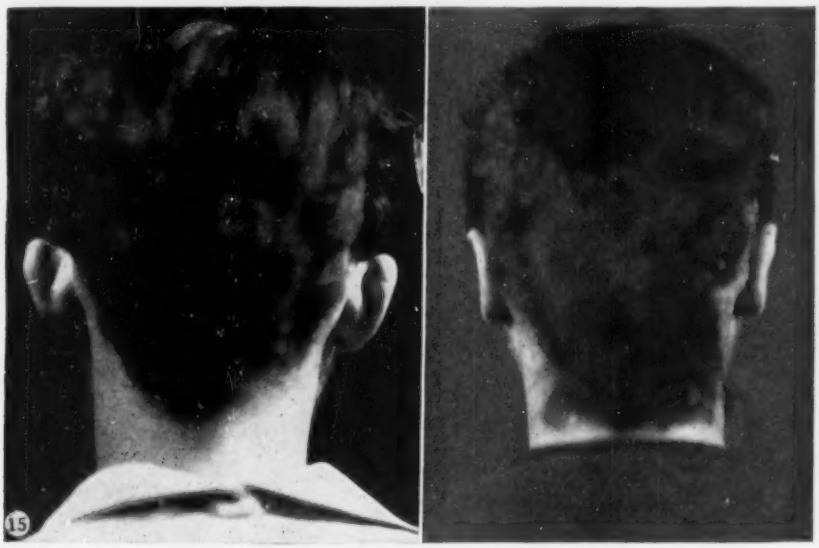

Fig. 15.—Rear view of patient in Figures 13 and 14 before (left) and after (right) operation.

with the skull, or the crease line. Another precaution is taken by leaving a comma-shaped island of cartilage over the deep concha, to maintain the contour of the cavum (Fig. *7b*). When all incisions are made and while the ear is on the stretch, the cartilage can be peeled off as one removes the skin from an orange.

The edges of the cartilage are then carefully trimmed and rounded so there will be no protrusion of the skin over the sharp edges on the front surface of the ear (Fig. 8 *a*). After the surgical field has been cleansed and completely freed from all bleeding, the subcutaneous tissue is sutured with 1-0 absorbable surgical (gut) sutures, and the skin is closed with nylon sutures. Nylon sutures have not been used in children, because of the thinness of their tissues. Instead, absorbable surgical sutures are passed through the skin and do not require removal, since they tend to break down and loosen, making them easy to dispose of without discomfort to the patient.

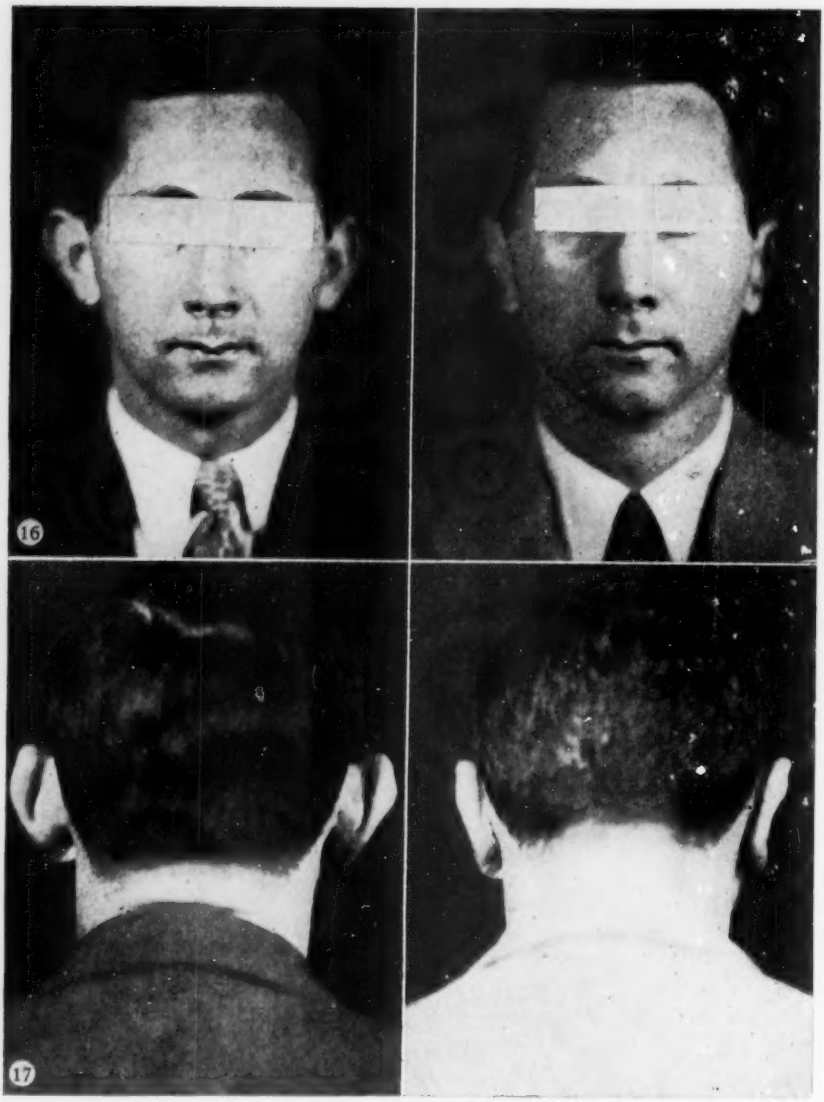

Fig. 16.—Front view of patient before (left) and after (right) operation.
Fig. 17.—Rear view of patient in Figure 16 before (left) and after (right) operation.

The skin of the area of operation is finally cleansed, and antiseptics are applied. A rubber drain is left in the wound for 24 to 48 hours.

Exact molds of the anterior surface of the ears are made before the operation (Fig. 9 *b*). Dental mold compound is softened by laying a piece of suitable size on a strip of gauze, which is held at either end hammockwise and dipped into hot water until it is pliable. The softened, flat sheet of compound is then carefully pressed into all the anterior parts of the ear to form a cast (Fig. 9 *a*). After the operation, the hardened mold is again fitted into the ear. To do this, the skin is painted rapidly with collodion on a fine brush; if too much time is taken in doing this, the collodion will begin to harden, but it can be softened again with hot water, though this should not be necessary. A layer of petrolatum (Vaseline) gauze is laid over the ear (Fig. 10 *a* and *b*), and the impression of dental mold is fitted into the ear cavity, to restore the original contour and act as a splint (Fig. 10 *c*). The dressing is held in place by a snug elastic bandage, which is left on for 48 hours, at which time the drain is taken out. The sutures are all removed on the seventh or eighth day.

There is one objection to this operative technique that might be raised, i. e., that it obliterates the postauricular sulcus. This objection rests particularly on the possible difficulty for the barber in cutting the hair in this region. But if the ear has been satisfactorily corrected, that is not the surgeon's problem nor the patient's, though it may be one for the barber.

Becker's operation is a good one, that does not obliterate the sulcus, but in my experience, I have found that hematoma may form, with a resulting cauliflower ear. The operation outlined above has given more consistently satisfactory results than others which I have used.

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THE SURGICAL TREATMENT OF WRINKLES

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CHICAGO

WRINKLES appear in the face because of special subcutaneous muscles attached directly to the skin of the facial region. When these muscles contract, they create, at right angles to their length, a series of furrows, which, because of failing resiliency in the skin, may become permanent. Where no subcutaneous muscles exist, wrinkles do not form. Bodily changes due to age are general, and there is gradual diminution of the underlying skeletal and muscle volume together with general loss of elasticity.

As a result of activity of the facial musculature, the skin of the face is permanently overstretched and, in the absence of elastic properties, hangs in folds and tends to gravitate over the lower parts of the face. This is caused by the inevitable sagging significant of the aging process; stretching of the skin after removal of tumors; folds and wrinkles as aftermaths of weight loss; irradiation and premature atrophy of the skin; relaxation of the skin as a sequela of facial paralysis, and so forth.

Important among the reasons for eradication of wrinkles of the face are senescence, which is more marked today because of the lengthening life span, and the emphasis of industry and society on youth and its concomitant appearance. Therefore, a description of a technique for surgical removal of wrinkles and sagging skin, employed by me with satisfactory and enduring results, and a discussion of the increasing recognition of the economic, sociologic, and psychologic needs for this procedure seem warranted.

The population increased 7.2% from 1930 to 1940, and the number of persons of 65 years of age increased 35%, according to the United States Bureau of Census.* The figures have greatly increased since these reports, in fact, by many hundreds of thousands a year. Thus the number of persons in the upper age brackets is increasing faster than the population as a whole. Senescence is not uniformly progressive, and if the visible skin of persons who are still vigorous and productive is subjected to an accelerated rate, they may be denied the privilege of pursuing the only career for which they are fitted. Industry gives preference to youth, disregarding the experience that comes with maturity. Persons in the older age group are definitely handicapped, but if they can be made acceptable to industry, socially and psychologically, the outlook for many will be improved and their productive years prolonged.

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* References 1 and 2.

In this regard, importance of esthetic indications cannot be denied. Mayer and Swanker [3] state that the desire to retain youth has plagued mankind from time immemorial. Cosmetics have been used since the time of Cleopatra. Ponce de León gave up his life trying to find the Fountain of Youth. Legends place the supreme premium on the gift of eternal youth. The belief that operative intervention merely pampers a patient's vanity is not justified. The opportunities for many can be materially enhanced by the proper surgical cosmetic correction of the wrinkled skin.

Pathologic indications for eradication of wrinkles are increasing as this surgical procedure is becoming commoner and better understood. Patients who have had facial paralysis for a period of time find that there is not only a palsy but also a stretching of the skin, with considerable relaxation. When a fascial sling is used

A
INSERTION OF STRIPS OF FASCIA LATA INTO CHEEK FOR PARALYSIS OF 7TH NERVE WITH REDUNDANT TISSUE EXCISED.
B
FRONT VIEW SHOWING STRIPS TO UPPER AND LOWER LIPS CROSSING BEYOND MIDLINE IN FRONT
C
INCISION CLOSED

Figure 1

to suspend the face, there is a redundancy of skin, and a much better physiologic and cosmetic result is obtained by excising this excess. Folds and wrinkles following weight loss, irradiation, and premature atrophy of the facial skin are definitely improved by rhytidoplasty. After excision of tumors of the cheeks, the skin is stretched to the extent that removal of the excess tissue is indicated. Superficial scars and blemishes resulting from disease and/or trauma are also concealed to a great extent by stretching the skin.†

Operation for correction of wrinkles is probably one of the most recent advances in surgery. Gersuny [4] in 1899 introduced the use of paraffin and obtained spectacular results. It was not until experience demonstrated its harmful effects upon unfortunate persons who were subjected to the treatment that the practice was abandoned and attention turned to surgery. Lexer [5] operated on this condition as early as 1906, but the first report was not published until 1920. Passot,[6] in 1919, and Joseph,[7] in 1921, devised further operative procedures for elimination of wrinkles. Since that time various modifications have been reported by Noël [8] and others.

† The role of rhytidoplasty in the correction of scars and disfigurements caused by accidental trauma will be discussed by me in a subsequent paper.

Surgeons performing this operation will find most successful results in well-adjusted persons whose skin hangs in folds and shows minimal destruction of elastic fibrils, with no scars or fatty infiltration. Duration of the results are dependent upon such factors as age, environment, emotional habits, heredity, and type of procedure performed. Age of the person at the time of operation bears a direct relationship to success of the procedure. The more relaxed tissues allow a greater degree of change and longer-lasting results. Except in the prematurely aged person or one in whom pathologic indications exist, rarely is much benefit derived before the fourth or fifth decade of life, because of insufficient relaxation and atrophy of the skin prior to that age.

Preoperative examination reveals that patients vary considerably, and individual planning of the procedure for each patient is necessary. However, the basic principles of the procedure remain fairly constant. Character of the face is found in the muscles of expression, attached primarily about the eyes, nose, and mouth. Therefore, in undermining, one should not disturb the muscle detachments in these regions, and any correction about the eyes should be reserved for a secondary operation of a minor nature.

Patients presenting themselves for a face-lifting procedure all have their own separate problems and reasons, such as bags under the eyes, double chin, folds of skin at the mandibular borders, and so forth. Some request the cosmetic correction for economic and sociologic reasons. Except in the case of the unstable person, the reasons for the various requests are well founded and legitimate. The unstable person, of course, is directed to psychiatric evaluation of the justification for the procedure, and many times the psychiatrist requests that such an operation be performed.

Preoperative and postoperative photographs are the most important single record. The patient may forget how he or she may have looked prior to operation; and unless these photographs are taken under identical conditions before and after surgery, they not only will be misleading but will give a false impression. For the same reason, retouching of the photographs is to be avoided.

A good impression of the correction to be made can be obtained by drawing the skin upward and backward with the hand in the direction of the proposed lifting. Extreme correction may be as undesirable as no correction. The lines of incision must be carefully chosen and should be placed within the hairline so as to assure maximum invisibility. This has the advantage of hiding the scar plus the added advantage of tissues which are tougher and better able to bear the tension of the suture. The final result is not absolutely permanent, and the tissues will probably start to sag again, but the tendency is slight and slow in becoming apparent. My method of procedure places the incision high above the hair line, and the results have been long-lasting and forecast more enduring corrections.

The wrinkles usually considered for eradication are those of the forehead, glabellar region, upper and lower eyelids, and wrinkles at the outer canthus, nasolabial folds, and neck. Application of the general principles, allied to anatomic knowledge and sound esthetic judgment, provides a guide to almost all likely conditions. In general, the incision, preferably crescentic or elliptical in shape, is always placed parallel to the main axis of the wrinkles and in as inconspicuous a position as possible.

Bagging in the lower eyelids can be relieved by incisions placed in the shadow of the lashes, to render them inconspicuous. Sagging of the skin below or around the margin of the jaw can be remedied by making a triangle-shaped incision just behind the ear, where it is hidden by the hair and the wing of the auricle. In vertical wrinkles occurring between the eyebrows, if they are deeply furrowed and there is much superfluous skin, an elliptical segment is removed longitudinally. However, if the furrowing is slight and the skin to be excised minimal, it is better to place a sigmoid-like incision on either side of the forehead.

Double chin usually involves excess adipose tissue in addition to excess skin. A transverse incision is made, the fat removed, and the skin excised after stretching. The incision should be placed in natural folds so as to be as inconspicuous as possible, and the excision must be symmetrical, to avoid any irregularity when healing takes place. Occasionally, perpendicular incisions are required for correcting double chin, but these should be avoided whenever possible, because of inability to disguise the scar. Facial paralysis is, as a rule, unilateral. However, it may be bilateral and require mechanical correction by means of fascia strips from the thigh combined with the face lift, to support the face.

In the operation several points are worthy of note. Unless the patient is able to remain in seclusion during the entire healing period, care is necessary in cutting the hair. Hair is shaved off only where the incisions are to be made, and the rest of the hair braided in front of the scalp wound and posterior to it. Because of this amount of hair left, care should be exercised so that none is allowed in the wound when closing, or healing will be greatly delayed. A large area is exposed surgically; therefore, asepsis is essential. Considerable undermining of a superficial nature is carried out. If this undermining is other than superficial, the filaments of the facial nerve are endangered. The extensiveness of the undermining, rather than the stretching of the skin, determines to a great extent the durability of the procedure. Hemostasis is essential, since the area of operation involves a highly vascular region.

In preparation for rhytidoplasty, the usual orders are given for preoperative and postoperative care, and the period of hospital stay is, in most cases, approximately 7 to 10 days. The period of facial discoloration is approximately 21 days following surgery.

OPERATION FOR FACE WRINKLES

A crescent of skin is removed behind the hairline in the parietal region and a triangle posterior to the ear. The incision begins almost at the vertex of the scalp, about 1.5 in. (4 cm.) posterior to the hairline anteriorly. It follows a curvilinear course downward to the point immediately in front of the junction of the upper part of the ear with the head. From here the incision extends downward immediately posterior to the tragus. The incision then curves around the lower attachment of the ear and thence upward immediately posterior to the ear; then it turns sharply posteriorly at a point about halfway up the ear for a distance of approximately 2 in. (5 cm.), then sharply downward, thence upward to meet the incision running posteriorly, removing a triangle within the hairline. Unless a unilateral condition due to some pathologic process is being corrected, such as facial nerve palsy, neurofibromatosis, or lymphoma, where the face is unduly stretched, the incisions are bilateral.

Undermining is then carried out above the superficial fascia, the undermining being extended to the wrinkled areas. Another incision is made beginning at the vertex of the original incision, anterior and parallel to it. At an estimated distance, the crescent is removed from within the hairline. A strip of skin is excised of such width that the closure slightly overcorrects the sagging yet without eradicating the normal expression of the face. Closure is begun at the site of the upper pole of the ear with a heavy suture. This is the key suture, and the rest of the closure is carried out with interrupted sutures. A firm pressure dressing is then applied for apposition of the skin and underlying tissues. This operation will care for the sag-

A
INCISION MADE FOR RHYTIDECTOMY WITH DOTTED LINE SHOWING EXTENT OF UNDERMINING

B
INCISIONS CLOSED, BUT SHOWING HAIR LEFT, BOTH ANTERIOR AND POSTERIOR, TO FACILITATE REHABILITATION

C
INCISION CAMOUFLAGED WITH HAIR, FOLLOWING OPERATION.

Figure 2

A
SHOWS INCISIONS FOR REMOVAL OF WRINKLES OF FOREHEAD

B
INCISION AFTER SUTURES APPLIED

Figure 3

ging and wrinkling of the lower border and angle of the jaw, nasolabial folds, cheeks, and double chin not due to fatty deposition.

The Forehead.—If only the forehead is affected, crescent-shaped incisions are made parallel to the main axis of the forehead wrinkles, within the hairline. The incisions are of ample length, and the skin is drawn up in order to estimate exactly the amount of skin to be removed. The determined amount is then excised. Skin around the incisions is thoroughly mobilized by undermining; this is followed by skin closure in the usual manner.

Glabellar Region.—Vertical wrinkles of the glabellar region are removed by two incisions lateral to the midline, within the hairline, and ellipsoidal in character. The skin is undermined and the estimated amount excised. Closure of the skin is then

made in the usual manner. An alternative method of excising the excess skin between the eyebrows with two elliptic incisions, then closure, has the disadvantage of visible scarring.

Upper Eyelids.—Skin folds in the upper eyelids giving a heavy, sleepy appearance are readily removed by simple crescentic excisions. The excisions are planned so that the resulting scar line will fall in the natural folds of the eyelid, in the open position of the eye. The line of this fold is marked out before operation, to indicate the width of the strip of tissue to be removed. Distortion of the eyelid margin is thus avoided. The skin crescent may be outlined by a scalpel and dissected away with scissors. Slight undermining of the wound edges allows a more perfect apposition of the skin. Skin edges are then sutured with fine nonabsorbable surgical (silk) sutures, and the sutures are removed in 48 hours. If the scar line is properly placed, it is difficult to find within a few weeks.

Wrinkles in the upper lids are, as a rule, less disturbing than in the lower lids, but because of less subcutaneous fat, they appear earlier than in the lower lids and often interfere with vision. The excision extends only through the skin of the lid, without disturbing muscle fibers. The incision is made from the inner canthus out-

Figure 4

ward to the outer canthus, and, as in the correction of folds, the amount of tissue is determined. The parallel incision forms a crescent toward the outer canthus.

Lower Eyelids.—Two types of bagginess, blepharochalasis and ptosis adiposa, are recognized in the lower lids. Blepharochalasis was first described by Fuchs [9] and is characterized by relaxation of the skin of the eyelid, caused by atrophy of the intercellular tissue. Sichel [10] described the condition of adipose ptosis, characterized by senile relaxation of the facial bands which connect the eye with the palpable muscles, and atrophy of the tarso-orbital fascia. Herniation of the interocular fat results, without skin redundancy, from the weakened fascia being pushed forward and eventually giving way, so that fat protrudes between the fibers of the orbicularis muscle, forming fat pouches under the skin.

Blepharochalasis is easily corrected by making an incision immediately beneath the lid margin, beginning at the inner canthus and curving the incision sharply downward and outward at the outer canthus. Care must be taken that the incision is neither too high, for fear of producing an ectropion, nor too low, resulting in a visible scar. Through this incision, undermining is carried downward for several millimeters. Beginning at the inner canthus, a strip of skin of the desired width is removed in the form of a crescent extending to the outer canthus, at which a triangle of skin is removed, using the prolonged incision above as one side of the triangle and downward from the lower incision to form the other side of the triangle. The skin is then closed with interrupted fine nonabsorbable (silk) sutures.

Ptosis adiposa is corrected by an incision extending from the inner canthus to the outer canthus, curving sharply downward and outward from the outer canthus for approximately 1 cm. The skin is undermined downward, exposing the orbicularis oculi muscle. The herniated fat is removed. Margins of the ruptured fat are imbricated and sutured with fine nonabsorbable sutures. Redundant skin is then excised in the same manner as for blepharochalasis and the skin closed with fine interrupted sutures.

COMMENT

It is to be emphasized that today correction of wrinkles and sagging skin by rhytidoplasty must be appraised as an important surgical advance in alleviating disfigurements, not as an empiric procedure or luxury to indulge a person's vanity.

The great implications in our population changes, because of the increasing number of senescents, make reevaluation of the potentialities of this group in industry and society of vital importance. Furthermore, with recent developments in therapy and chemotherapy, one sees more facial deformities in both the younger and the older age groups, because of reduced mortality from disease and trauma.

In both the senescent and the general population with disfiguring wrinkles, sagging skin, and scars, rhytidoplasty is of inestimable value in the armamentarium for assisting this handicapped group in securing and maintaining useful participation in employment and rehabilitation in the life of the community.

The scope of the present paper has been limited to the surgical removal of wrinkles of the skin and sagging due to age and disease per se. The value of rhytidoplasty in the correction and alleviation of residual scars and disfigurements resulting from accidental trauma will be dealt with in a subsequent article.

In most cases I have had classic results with this surgical procedure. One primary reason seems to be that the operative incision is placed high in the scalp, almost at the vertex, giving higher and more satisfactory support. Then too, with the placement of the incision in such a position, there is no visible scarring, and the site of incision eventually assumes the appearance of a natural crease in the skin.

Cognizant of the potential recurrence of wrinkles and sagging of the facial skin, I have found the particular technique employed to be preeminently superior, for, while the immediate results have been cosmetically and physiologically satisfying, from the aspect of permanence, they have also been highly promising.

SUMMARY

Various causes of wrinkles and sagging skin of the face, forehead, glabellar region, and eyelids are discussed with the essential reasons for their surgical correction.

A successful technique of operation employed by me for removal of wrinkles and redundant skin is described.

The good results obtained and the prognosis of long-lasting corrections are attributed in large measure to location of the operative incision.

Importance of rhytidoplasty is stressed for enhancement of the industrial, sociologic, and psychologic rehabilitation of the growing senescent population and for the correction of wrinkles and sagging skin resulting from disease.

6 N. Michigan Ave.

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NEW HEARING TEST ABOVE THRESHOLD AND ITS CLINICAL SIGNIFICANCE

Nature of the Recruitment Phenomenon

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I. INTRODUCTION

TO INDICATE the hearing acuity by audiometer, the lowest pattern of threshold is generally used. No questions regarding this method have so far been raised. Hearing acuity, however, is important for speech on the one hand, and hearing above threshold is practically important on the other. The threshold alone, therefore, does not perfectly indicate practical hearing. In other words, the threshold value indicates the hearing acuity only when the intensity of the presented tone is parallel with the loudness or perceived tone.

Fowler (1928), however, found a phenomenon in which the loudness rapidly increases in correspondence to small increases in intensity, and he called this phenomenon "recruitment" of tonal loudness. From this fact we cannot say in cases in which this phenomenon exists that the threshold pattern indicates actual hearing. Fowler [1] (1936) published the balance test of loudness with the binaural loudness comparison and emphasized the possibility of differentiation of perceptive deafness from conductive deafness and its clinical significance.

Since then, many supplementary examinations of this phenomenon have been made, with results both pro and con. Regardless of these examinations, this balance test needs a difference of hearing power in the two ears. The majority of patients with so-called perceptive deafness show similar hearing loss in both ears, and so many cases of perceptive deafness are not actually diagnosed by this test, even if Fowler's opinion is correct. Hence, many efforts were made to prove the recruitment phenomenon in one ear alone, namely, by Reger,[2] de Bruine-Altes,[3] Gardner,[4] Békésy, Lüscher and Zwislocki,[5] Denes and Naunton,[6] and others.

We investigated the recruitment in one ear by our new method and compared it with our other studies. From these investigations and examinations we can conclude that a new hearing test above the threshold, proposed by us, has the possibility of differentiating the various lesions in cases of perceptive diseases —lesions of the inner ear from those of the hearing center.

We report here our method, its clinical significance, and its fundamentals.

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II. SELECTION OF SUBJECTS

The tympanic membranes and the auditory tubes were examined; the tuning-fork test was made, audiograms were taken, and causes of the diseases were precisely examined for classification of conduction, perception, and combined deafness. From among the subjects, cases of pure conductive and pure perceptive deafness were selected for study.

III. METHOD OF EXAMINATION

1. The hearing-loss curve was prepared. 2. A tone 20 db. above threshold was applied to the subject, and the loudness was kept in mind. 3. A point was decided on, by increasing from 0 db., at which the tone of the same frequency has the same loudness as the former tone. 4. A point was decided on, by decreasing from 90 db., at which the same frequency has the same loudness as the former tone. Here, for each frequency, some range occurs between the first and second points. The distance between these points was taken as the result. The modulations were carried out not only at 20 db. above threshold but also at 40 and 60 db. above threshold, but we describe here mainly the results obtained at 20 db. above threshold.

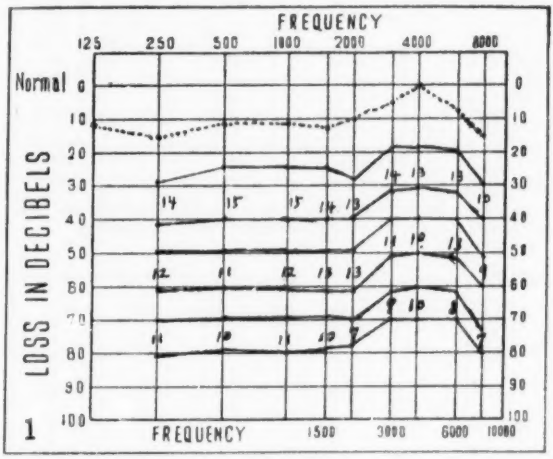

Chart 1.—Hearing range in normal subjects. Broken line, hearing threshold; solid line, hearing above threshold; number, range in decibels.

IV. RESULTS

For a control, we tested normal persons by our method. The results obtained are shown in Chart 1; the ranges were 8 to 15 db. at 20 db. above threshold, 8 to 13 db. at 40 db. above threshold, and 7 to 11 db. at 60 db. above threshold. The ranges in chronic conduction deafness were, as described in Chart 2, normal or a little above normal, i. e., 10 to 20 db.

The ranges in acute conduction deafness were different from those in chronic conduction deafness. Of this difference we intend to write on another occasion and hence the reason for this difference is omitted here.

In cases of perceptive deafness, evidently some have narrow ranges (Chart 3); some have wide ranges (Chart 4), and some have almost normal ranges (Chart 5). That is through the use of our hearing test above threshold, we were able to

divide perception deafness into three groups: cases with normal, narrow, and wide ranges. Therefore, we tried to determine which type of case had a wide or narrow range.

The relation between the type of audiogram and the size of the range was first examined; in the abrupt-loss type of audiogram the range is always narrow

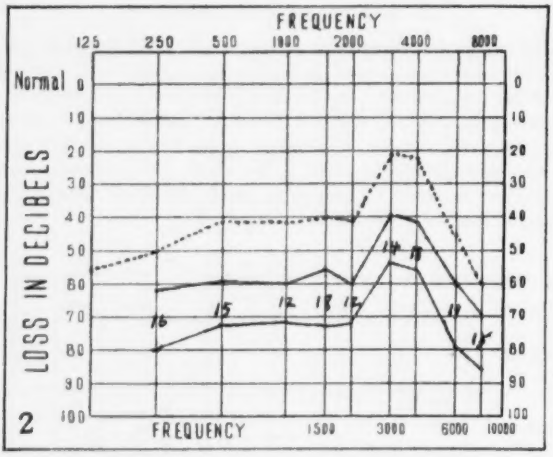

Chart 2.—Hearing range in subjects with chronic conduction deafness. Broken line, hearing threshold; solid line, hearing above threshold; number, range in decibels.

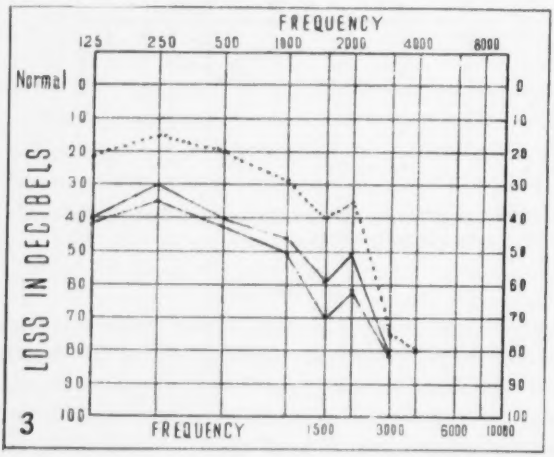

Chart 3.—Narrow hearing range in subjects with perception deafness. Broken line, hearing threshold; solid line, hearing above threshold.

at abrupt frequency, and in the horizontal-loss type of audiogram some cases have normal range, some have wide range, and some have narrow range. So it is not possible to say that the type of audiogram has no relation to the range, but it is impossible to say that the type of audiogram has direct and close relation to

the range. The relation between the causes of hearing loss and the size of the range was next examined; in Ménière's disease some cases have a narrow range only at abrupt frequency; some have narrow range at abrupt frequency and wide range at other frequencies. In acoustic trauma some have normal range;

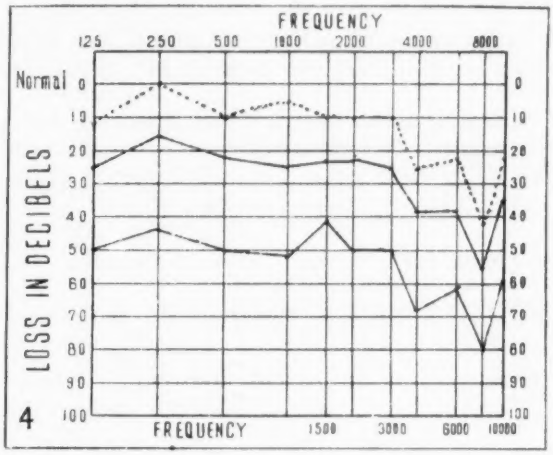

Chart 4.—Wide hearing range in subjects with perception deafness. Broken line, hearing threshold; solid line, hearing above threshold.

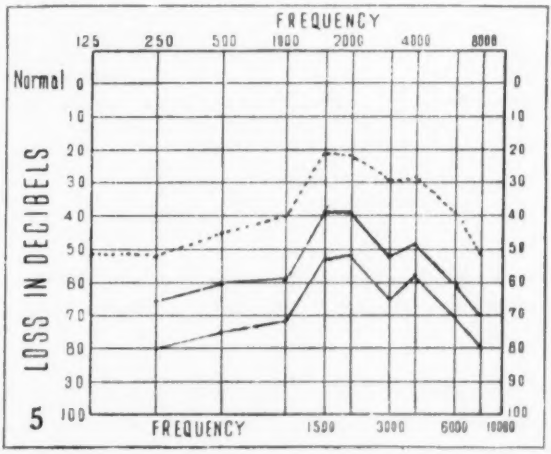

Chart 5.—Normal hearing range in subjects with perception deafness. Broken line, hearing threshold; solid line, hearing above threshold.

others have narrow range at abrupt frequency. In traumatic deafness this test shows normal range. In presbycusis normal and narrow ranges were recognized. In central deafness some cases have normal and wide ranges; others have a wide range at each frequency.

In Ménière's disease and deafness due to noise the ranges were often narrow, but in central and traumatic deafness many cases showed wide ranges.

The relation between the duration of the disease and the range was also examined. Many cases of narrow range were observed among cases of short duration, but this relation was not intimate, and almost all cases of short duration were Ménière's disease.

Accordingly, many narrow ranges were obtained in cases of the abrupt type of high-tone deafness—etiologically, in Ménière's disease and deafness due to

TABLE 1.—*Variations in Hearing Range in Relation to the Cause of Hearing Loss*

	Patients, No. Type of Hearing Range					
Cause of Hearing Loss	Wide	Middle	Narrow	Wide and Middle	Middle and Narrow	Wide, Middle, and Narrow
Unknown	..	5	4	2	5	2
Ménière's disease	..	2	6	1	2	1
Presbycusis	..	2	..	4	1	1
Toxic	..	1	2	..	..	..
Traumatic	..	..	..	2	1	..
Acoustic trauma	..	1	4	..	..	..
Electric trauma	..	2	..	..	..	..
Central	2	..	..	3	..	1
Hereditary	1	..	1	..	..	..

TABLE 2.—*Variations in Hearing Range in Relation to Duration of Disease*

	Patients, No. Type of Hearing Range					
Duration of Disease	Narrow	Middle	Wide	Middle and Narrow	Wide and Middle	Wide, Middle, and Narrow
1 mo.	3	..	..	2	2	..
3 mo.	4	4	..	1	1	.
6 mo.	4	..	..	..	1	1
1 yr.	..	2	..	1	3	1
3 yr.	4	5	2	2	5	1
5 yr.	..	1	..	1	..	..
10 yr.	..	1	..	1	..	1
Over 10 yr.	2	..	1	2	.	1

noise. It is assumed from this fact that the narrow range is to be found in cases of a lesion of Corti's organ.

V. APPEARANCE OF THE RECRUITMENT AND ITS NATURE

Our test is a kind of difference limen test of loudness but does not directly show difference limen.

It is assumed that the narrow range shows a lesion of Corti's organ; therefore, if the recruitment phenomenon is recognized in lesions of Corti's organ alone, our test has a relation to the recruitment phenomenon. The recruitment phenomenon we studied recently, but only by a subjective method. This is natural from its definition, but this phenomenon should become more evident if it can be secured objectively. Therefore, we undertook the following experiment:

We examined the comparative relationship between the cochlear response and increase in intensity of the stimulating tone in both normal and experimentally damaged Corti's organs in the cat.

Our point of view in this experiment is that if the recruitment phenomenon appears in lesions of Corti's organs, the cochlear response in pathological conditions of Corti's organ should suddenly become greater with increase in intensity of the stimulating sound. We measured the amplitude of the cochlear response to a frequency of 1000 in cats on an oscillograph with a Brown tube, using the apparatus shown in Chart 6.

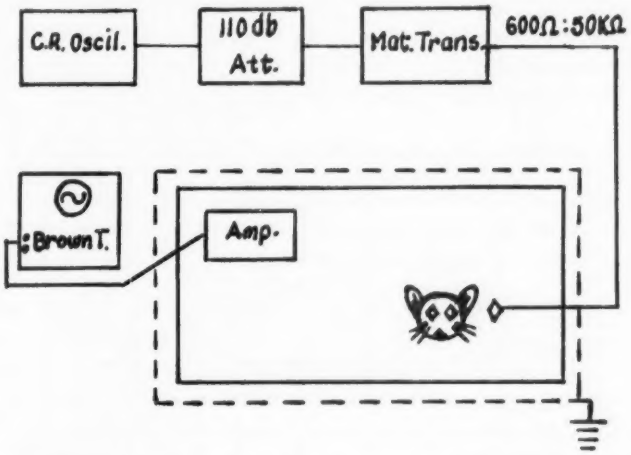

Chart 6.—Diagrammatic representation of the apparatus used in measuring the amplitude of the cochlear response in cats.

TABLE 3.—*Results in Cats Acoustically Traumatized with a Sound of 1000 Cps*

	Amplitude			
		Pathologic Ear *		
Decibels	Normal Ear	30 Min.	60 Min.	120 Min.
—20	1.0	1.0	1.0	1.0
—15	1.25	1.2	1.35	1.2
—10	1.5	1.8	1.8	1.5
— 5	2.0	3.2	2.6	2.0

* The stimulation was a sound of 1000 cps at 90 db. for 30, 60, or 120 minutes.

In this experiment we first measured the amplitude of the attenuator at 0 db. (20 db. on the cathode-ray oscillograph); then we measured the amplitude with every decrease in 5 db. The results thus obtained were considered to be the amplitudes corresponding to each intensity in the normal ear. Next we measured the amplitudes corresponding to each intensity in pathological ears which were acoustically traumatized with a sound of 1000 cps at 90-db. intensity for 30 minutes, 1 hour, or 2 hours. The results are shown in Table 3.

Thus the amplitudes of cochlear response in normal cats grew greater with increase in intensity of the stimulating tone, and its rate of increase was pro-

portional to the increase in intensity, but in pathological ears the amplitudes grew greater with increase in intensity of the stimulating tone but not in proportion to the intensity, resulting in a sudden rise. The variations in the amplitudes were especially evident at intensities between minus 10 db. and minus 5 db., i. e., when the amplitude at an intensity of minus 10 db. is supposed to be 1, it is 1.3 as great in a normal ear, 1.8 as great in a 30-minute stimulated ear, and 1.5 as great in a one- or two-hour stimulated ear at an intensity of minus 5 db.

From this experiment it is possible to say that the sound-deafened ear feels sound of increased intensity to be much louder than normal. In other words, we understand that the recruitment phenomenon should appear. We can also conclude from this experiment that recruitment occurs in cochlea deafness and that the recruitment phenomenon occurs in cases of lesions of Corti's organ. We can make clear the apparent portion of recruitment and its basis.

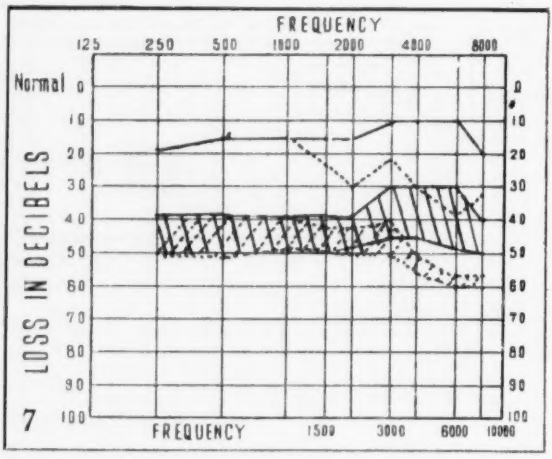

Chart 7.—Hearing range in normal subjects before (solid line) and after (broken line) sound stimulation.

VI. BASIS OF THE HEARING

Then what is the basis of our hearing test above threshold? We must make this clear. After we tested normal persons by our test, we tested them after the ear was stimulated for 30 minutes with 1000 cps at 90-db. intensity.

According to this experiment, the range evidently became narrowed at high tones, the threshold was raised by sound stimulation, and the range remained normal at tones for which the threshold was not raised (Chart 7).

In our test, ranges became narrow in cases of acoustic lesions of Corti's organ. The ranges, according to our test, were clinically narrow in Ménière's disease and deafness due to noise, as mentioned above. We also found from our experiment on cats that the recruitment phenomenon appeared in cases of lesions of Corti's organ. From these results, we believe that the narrow range obtained

by our test indicates lesions of Corti's organ and the existance of recruitment. In other words, a narrow range is of the same nature as recruitment and its basis is a lesion of Corti's organ.

VII. CLINICAL SIGNIFICANCE

It was found that the ranges obtained by our test were mostly narrow in Ménière's disease and deafness due to noise and that the ranges became narrow in experimentally induced acoustic trauma. It is considered that Corti's organ is damaged in the initial stage of acoustic trauma and in Ménière's disease, or labyrinthine hydrops. From these facts and considerations, we can say that the narrow ranges obtained by our test indicate lesions of Corti's organ.

But we must explain the fact that there were normal ranges in some cases of Ménière's disease and deafness due to noise. Cases of so-called perception deafness which showed normal range were neuritis acoustica in the initial stage, and Ménière's disease, or deafness due to noise of long duration. It is considered from these clinical facts that cases of lesions of the acoustic nerve should show normal ranges. And it is considered from our studies on labyrinthine fluids that the ranges should be normal in cases of variated labyrinthine fluids. Therefore it is natural that there were various ranges in perception deafness corresponding to the extent of the lesion and that the ranges were wide in pure central deafness.

From the above-described results we can assume a clinical significance of our hearing test above thrshold as follows: 1. Cases which show narrow ranges indicate a lesion of Corti's organ. 2. Cases which show normal ranges have either a lesion of the acoustic nerve, variations of labyrinthine fluid, or lesions both in the acoustic center and Corti's organ. 3. Cases which show wide ranges have lesions of the acoustic center. In other words, our test makes possible local diagnosis of lesions in perception deafness.

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LARYNGEAL TUBERCULOSIS

Diagnosis, Incidence, and Present-Day Treatment

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THE OBJECT of this paper is an attempt to correlate my experience with laryngeal tuberculosis encountered in the process of laryngoscopic and bronchoscopic examinations of patients with pulmonary tuberculosis during the past 12 years.

Part of this experience was obtained from patients seen in my own private practice and also from those patients referred to me when I was head of the bronchology department of several hospitals. These patients, suffering from tuberculosis, were referred for laryngoscopic or bronchoscopic examinations from the various departments of these hospitals. The other part of my experience was obtained from the wealth of material with which I came in contact while associated with the Pennsylvania State Sanatorium for Tuberculosis.

I shall always have the greatest admiration for the courage, stoicism, and everlasting faith present in these unfortunate, afflicted persons, ever clinging to the hope that some day they would be cured of their disease. A closer understanding of the tortures experienced by these patients and of their determination to keep fighting in spite of being separated from their loved ones and the realization that their dreams and ambitions might never be realized and that their fondest hopes are forever shattered only strengthens one's admiration of their courage and one's desire to help them. Throughout the years this sympathy has become stronger and stronger.

It was back in 1936 when I first became interested in laryngeal tuberculosis. This interest was aroused by the impression made upon me by a sad case I saw at that time. A close friend of mine, 22 years of age, consulted me because of a recent development of symptoms of a lumpy sensation in his throat, an irritative cough with transient hoarseness, and difficulty in swallowing. A glance at him revealed that he had lost considerable weight. The history briefly was that he had been ill for the past six months, during which time he had been treated regularly by his family physician for low blood pressure. In spite of this, he had become progressively weaker, to the point where he had to stop working. Mirror examination of the

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larynx revealed boggy edema of the mucous membrane of the entire larynx, particularly in the region of the posterior commissure and arytenoids. The mucous membrane was very anemic but smooth. The immediate impression was that he was suffering from some serious systemic disease. Pulmonary tuberculosis was not at first considered seriously, because he volunteered information that he had been fluoroscoped several months before and told that his chest was negative. During the course of preliminary studies an x-ray examination of his chest was obtained, which revealed far advanced parenchymal infiltration involving both upper lung fields. The sputum examination was reported as Gaffky V concentration of tubercle bacilli. In spite of the best efforts in the treatment of his pulmonary and laryngeal lesions, this patient died in six months of complicating tuberculous meningitis. To this day I am puzzled by the fact that although this patient's wife and infant daughter, 18 months of age, had been in close contact and exposed to such virulent organisms which killed him they never contracted the disease.

It is of interest in this respect to quote Riggins and Gearhart [1]:

> Continued studies along these lines may afford a still better understanding of many baffling aspects of this protean disease, of man's varied reaction to it, and of its etiological agent.
>
> For example, it would be of utmost importance to know how and why the tubercle bacillus has the rather unique distinction of producing caseation, necrosis and liquefaction; why characteristics and clinical patterns of the disease differ so profoundly in different animals and species, and in the same animal (man) at different ages and among different racial groups; why it is acute in some and chronic in others; why it tends to localize in some and generalize in others; why it heals readily in some and progresses rapidly in others; why it confers relative immunity in some and rapidly destroys others.

In spite of the tremendous progress made toward a better understanding of these problems since Koch first identified the tubercle bacillus, there are still many phases of the disease that remain unexplained.

Pulmonary tuberculosis, with its potential complications, has been one of man's eternal problems. So long as tuberculosis continues to be responsible for the death of millions of people throughout the world, a most important part of man's fight against this dreaded disease remains to be attained. Thus man throughout the centuries has been in constant struggle with the micro-organisms that have tried to bring about his destruction. The remarkable advancements in the field of antibiotic therapy in the past 10 years are bringing to a closer realization the coveted hope that some day in the near future pulmonary tuberculosis, once the scourge of mankind, may be completely controlled like many of his other enemies.

Although laryngeal tuberculosis today is becoming a waning clinical entity, it was not in the far past when it was considered a dreaded complication, and, unfortunately, in spite of the then known means of treatment, many of the patients with the advanced type of involvement continued a progressively downhill course and died. Because of the favorable means of treating laryngeal tuberculosis today, it behooves us to be ever alert to the early onset of this condition so that therapy may be immediately instituted.

Pancoast [2] and, later, Taylor and Nathanson [3] have emphasized the value of roentgenograms in differential diagnosis of laryngeal lesions; but although x-rays may have merit in certain cases, they may also have their pitfalls. Since the larynx can be well visualized in practically 95% of the patients by such a simple procedure

as mirror laryngoscopy, it is surprising that it is not more frequently used by all members of the medical profession. To the experienced laryngologist the careful examination of the larynx not only reveals the natural appearance of these structures but may also be of secondary aid in the differential diagnosis of possible systemic disease. Paralysis of a vocal cord should arouse suspicion of potential intrathoracic pathology, such as aneurysm, a mediastinal tumor, or other forms of pressure upon the course of the recurrent laryngeal nerve. Allergic manifestations, such as angioneurotic edema, or sensitivity to drugs may produce evident changes in the laryngeal structure. In some cases the routine laryngeal examination may be the first means of arousing suspicion of the possibility of pulmonary tuberculosis in a person who never had any frank symptoms of the disease.

That the larynx may be involved in persons of apparent robust physique with early minimal pulmonary tuberculosis was further substantiated in cases picked up during a routine survey, which will be subsequently presented.

TABLE 1.—*Degree of Pulmonary Involvement in Patients with Laryngeal Tuberculosis*

		Extensive Bilateral Involvement	
	Patients, Total No.	Patients, No.	%
Males	395	298	75
Females	370	286	77

TABLE 2.—*Number of Patients with Laryngeal Tuberculosis Having Positive Sputum*

		Positive Sputum	
	Patients, Total No.	Patients, No.	%
Males	395	230	58
Females	370	179	48

Having had the privilege of being consultant bronchologist and laryngologist to the Pennsylvania State Sanatorium for Tuberculosis from 1940 to 1952, I had the opportunity of seeing a large number of patients with laryngeal tuberculosis. With the aid of the medical director of that institution, several surveys were made relative to the incidence of laryngeal tuberculosis at the sanatorium, and the results of one of these complete surveys included 395 males and 370 females. That most of these patients had radiological evidence of far advanced pulmonary tuberculosis is shown in Table 1.

A glance at Table 1 reveals that 75% of the males and 77% of the females in this study had far advanced bilateral parenchymal disease. Table 2 shows the proportion of these patients who had positive sputum and reveals that 58% of the males and 48% of the females showed different concentrations of tubercle bacilli in their sputum examination at the time of this study (although most of them had been positive at one time or another on admission to the institution).

Because of the protean manifestation of laryngeal involvement seen in this series of cases, any attempt at classification had to be arbitrary and of necessity have a fairly wide range if all the different types of changes seen were to be recorded.

Wilson,[4] in his report of 672 cases of laryngeal tuberculosis, used the terms incipient, moderately, and far advanced, as shown in the following tabulation from his article:

Tuberculous Laryngitis	Cases
Incipient	209
Moderately advanced	192
Far advanced	271

In order to allow for the inclusion of the earlier forms of involvement in which many cases showed only minimal inflammatory changes but had to be considered as possibly tuberculous in nature on account of the fact that the patients had definite pulmonary lesions and had (or had had at one time or another) positive sputum, a classification of wider latitude into four types was considered advisable in this study, namely:

Type I Larynx showed only mild inflammatory changes

Type II In addition to inflammatory changes, a beginning of a superficial erosion of the mucosal surface

TABLE 3.—*Incidence and Degree of Involvement of the Larynx in 370 Female Patients with Laryngeal Tuberculosis*

Laryngeal Involvement, Degree	Patients	
	No.	%
No involvement	223	60.2
Type I (minimal involvement)	49	13.2
Type II (moderate involvement, erosion of mucosa, etc.)	74	20.0
Type III (moderately advanced, superficial ulceration, edema, early granuloma)	16	4.3
Type IV (far advanced, destructive changes of laryngeal structures)	8	2.1

Type III Early ulcerative changes, edema, and granulomatous formation

Type IV Only the far advanced, destructive changes with seemingly irreparable damage, i. e., amputation of epiglottis, far advanced ulcerative invasion, and stenotic changes of the larynx proper

No attempt was made in this analysis at classification of the lesions into intrinsic and extrinsic, as employed by Wilson and other investigators, because it was felt that it would only add confusion, since even in many of the early lesions seen there was often involvement not only of the vocal cords and glottis but also of the ventricular bands and epiglottis.

In accordance with the classification adopted above, a glance at Table 3 reveals 13.2% of the female patients studied showed minimal involvement, whereas 20% had moderately early extension. Fortunately, only 4.3% had early destructive changes and only 2.1% far advanced, hopeless involvement.

A glimpse at Table 4 shows the incidence of minimal involvement to be much higher in the male patients, namely, 18.6%. However, the moderately early lesions were slightly lower, 19.7%, whereas the moderately advanced lesions were almost identically the same as in the female patients. The far advanced destructive changes were slightly less, 1.5%.

At first glance the incidence of laryngeal involvement of 40% in the females and 44% in the males would seem rather high. However, when one considers that the earliest types of alteration or deviation from the normal were recorded, and since the changes in Type I may have been purely inflammatory without any actual tuberculous involvement, then the degree of involvement, although still slightly high, would appear in closer accord with the results of other investigators.

Dworetzky,[5] in a very early paper, reports 25.6% incidence of laryngeal tuberculosis. In a later study Looper and Schneider[6] reported an incidence of 15.5% in a series of 3,227 patients. However, in a more recent survey of 2,770 patients, Looper and Lyon[7] found an incidence of only 7.7%, which certainly is extremely low in view of my findings. Myerson,[8] in 1944, also reported a low degree of involvement, finding only 10.6% laryngeal complications in an unusually large survey of 10,657 cases.

TABLE 4.—*Incidence and Degree of Involvement of the Larynx in 395 Male Patients with Laryngeal Tuberculosis*

Laryngeal Involvement, Degree	Patients	
	No.	%
No involvement	221	56.2
Type I (minimal involvement, slight inflammatory changes of mucous membrane)	74	18.6
Type II (moderate involvement, erosion of mucous membrane, etc.)	78	19.7
Type III (moderately advanced, superficial ulceration, edema granulomatous, etc.)	16	4.0
Type IV (far advanced, destructive changes of structures of larynx)	6	1.5

A review of the English literature reveals a higher incidence than that reported by Looper and Lyon,[7] and Myerson,[8] as shown in the following tabulation:

	Male	Female	Total
Number of patients with tuberculosis examined	2,130	701	2,831
Number of patients with laryngeal tuberculosis found	288	140	428
%	13.5	20.0	15.08

Wilson,[4] commenting on relationship of laryngeal tuberculosis to degree of pulmonary involvement states:

> The comparative percentage today of cases of laryngeal involvement with reference to cases of pulmonary disease suggests a revision of the figures of past years. The approximate estimate now is certainly less than 5 per cent for cases of minimal pulmonary disease, probably less than 10 per cent for cases of moderately advanced disease, and not more than 20 per cent for cases in which the pulmonary infection is far advanced.

In the process of this study an attempt was made to correlate not only the incidence of laryngeal involvement but also the extent of involvement in the different age groups, which is represented in Table 5.

This reveals that the predominant degree of involvement was of Type II, both in the male and female, with Type I next in frequency. Of additional interest is the fact that persons between 15 and 20 years of age in both sexes showed involvement of the first three types, but none had the far advanced lesions, whereas Type IV was prevalent in the ages between 21 and 40 in both men and women. As has been

observed before, laryngeal extension was definitely higher in the women between the ages of 20 and 30. No patients under 15 years of age were encountered in this group.

In view of the fact that 75% of the males and 77% of the females had advanced bilateral lesions and only 58% of the first and 48% of the latter had positive sputum, it was thought interesting to try to establish whether this had any relationship to the various types of laryngeal involvement.

TABLE 5.—*Degree of Laryngeal Involvement at Different Age Groups in 395 Males and 370 Female Patients*

Laryngeal Involvement, Degree	Age Group, Yr.											
	15-20		21-30		31-40		41-50		51-60		61	
	M	F	M	F	M	F	M	F	M	F	M	F
Type I	8	12	36	22	19	10	10	4	4	1	3	0
Type II	8	10	22	38	19	8	14	12	12	6	3	0
Type III	1	3	4	8	6	3	3	1	1	1	1	0
Type IV	0	0	2	5	4	2	0	1	0	0	0	0

TABLE 6.—*Relationship Between the Type of Laryngeal Involvemnt and the Type of Sputum*

Laryngeal Involvement, Type	Positive Sputum Patients		Negative Sputum Patients	
	Male	Female	Male	Female
Type I	49	19	25	30
Type II	60	54	18	20
Type III	13	14	3	2
Type IV	6	8	0	0

TABLE 7.—*Bronchoscopic Observations in a Series of 500 Cases of Pulmonary Tuberculosis*

Bronchoscopic Observations	%
Superficial erosion of tracheobronchial mucosa	38
Ulceration of tracheobronchial mucosa	23
Stenotic changes in trachea and bronchi	16
Bronchiectasis and tuberculosis	9

This definitely reveals a preponderance of laryngeal involvement in the patients with positive sputum, both in the male and female. This is particularly demonstrated in the more advanced forms of involvement, particularly Types III and IV. Since all the patients originally had positive sputum, it is interesting to note that in spite of the fact that their pulmonary lesions were being controlled to a point that they had become sputum negative, some form of laryngeal involvement was still apparent in 46 of the males and 52 of the females in this group.

For comparative information as to the possible relationship of tracheobronchial involvement to the laryngeal lesions, a review of the bronchoscopic findings was made of 500 patients bronchoscoped during this period. The results of this study are briefly summarized in Table 7.

In view of these findings it is not surprising that the incidence of laryngeal complications is higher than that reported by other investigators. Sweany and

Behm,[9] in an autopsy study of 667 tuberculous patients, noted bronchial disease was present in 377, or 56.6%, as gross bronchial lesions and in 37.5% of the remainder as histologic lesions of mucosal tuberculosis.

O'Keefe [10] reports the following bronchoscopic observations in his experience with tracheobronchial tuberculosis:

Localized ulcerations	20.4%
Diffuse ulcerations	52.2%
Inflammatory stenosis	27.2%

He further states:

The etiology of these complications is, of course, the tubercle bacilli, present in the infected secretions of the pulmonary lesion. Dissemination of this exudate throughout the tracheobronchial tree lessens the concentration of tubercle bacilli, thereby reducing its infectiousness as it approaches the larynx. It is reasonable to infer, then, that the earliest lesions should be found closest to the source of infection. Such actually is the case: bronchial lesions are noted more than three times oftener than those of the larynx.

TABLE 8.—*Incidence of Laryngeal Tuberculosis in 408 Males and 316 Female Patients Not Admitted to a Sanatorium*

	Male Patients		Female Patients	
Laryngeal Involvement, Type	No.	%	No.	%
No involvement	299	....	247	....
Type I	46	11.1	29	9.1
Type II	51	12.5	32	10.1
Type III	8	1.9	5	1.5
Type IV	4	0.9	3	0.9
Total	408		316	

These observations would lead one to conclude that the higher the degree of severe tracheobronchial involvement the higher would be the potential involvement of the larynx proper, which was borne out in my studies.

In order to obtain relative information as to the incidence of laryngeal tuberculosis in patients not admitted to a sanatorium, a survey was made of a series of patients seen in the bronchologic clinics of six different hospitals for bronchoscopic and laryngoscopic opinion in reference to their pulmonary tuberculosis. The majority of these patients were ambulatory and referred from the chest and other clinics of these various hospitals. The others constituted house patients who were receiving either medical or surgical treatment for their pulmonary tuberculosis. This survey included 408 males and 316 females. Table 8 reveals the results of this study; the same mode of classification was used as in the survey made of patients seen at the State Sanatorium.

This group of patients showed a definite lower incidence of all the different types of laryngeal involvement, which may be explained in part by the fact that most of these patients did not have the far advanced type of pulmonary tuberculosis present in the series studied at the State Sanatorium. Another factor may be that in this group the disease was of shorter duration and sufficient time had not elapsed for development of laryngeal extension. The high incidence in cases studied at the

State Sanatorium cannot be explained on the basis of any deficient medical care, since, from personal observation, I can vouch that under the capable administration of the medical director of that institution the patients received the highest type of medical care that anyone could expect.

The difference in the findings of these two groups probably aided in reconciling the discrepancy found according to the reports of different investigators.

PRESENT-DAY TREATMENT OF LARYNGEAL TUBERCULOSIS

The campaign against tuberculosis had its real start in 1882, when Koch discovered the tubercle bacillus. How effective this campaign has been can be illustrated by the following statistics:

In 1882 the death rate from this disease in the United States was estimated at 245 per 100,000 population. It dropped 50% in the first 40 years and 80% in 50 years, to a rate of 49 per 100,000. For the last 10 years it has dropped an average of 2% a year. In spite of this marked decline, this disease still takes more than 50,000 lives a year in the United States alone. It still remains the principal cause of death among white women 20 to 35 years of age, accounting for about one-fifth of all deaths in this group. Among white men tuberculosis ranks second only to accidents in the prime ages, from 20 to 39 years, and in spite of all the progress made, the fact remains that nearly 175 persons die every day in the United States from tuberculosis.

Although no actual statistics are available as to the exact number that may have died as the direct result of laryngeal complications, one might conservatively estimate that, since 10% of the patients with pulmonary tuberculosis have laryngeal complications, at least one-tenth of these patients may have died from this cause. Consideration of this fact should not only stimulate interest in the treatment of pulmonary tuberculosis and its complications but, better still, the cognizance that we are dealing with a health problem of great magnitude, which offers a definite challenge in the field of preventive medicine. This can only be achieved by education of the public as to the nature and prevention of tuberculosis and stimulation of the desire to stamp it out. This also requires the aid of physicians and nurses in the early recognition of symptoms of tuberculosis and in the guidance of the patient in the use of roentgenograms and other studies to establish the diagnosis. There is a need for cooperation between the medical profession and the public in carrying out, in the spirit of good citizenship, an accepted plan of control and for the recognition by every doctor of his obligation to act as a public health servant by virtue of his legal license to practice medicine, which does not limit him to curative medicine alone.

As far back as 1877, while bacteriology was still in its infancy, bacterial antagonism, or antibiosis, was being noted by Pasteur and Joubert [11] and others. While working with anthrax bacilli, they observed that these organisms grew rapidly on neutral or slightly alkaline urine until the urine was inoculated with one of the "common bacteria," after which the anthrax bacilli showed little or no growth. In the same paper they reported that animals susceptible to anthrax infection could be protected from developing the disease by the simultaneous injection of some "common bacteria." They concluded that "these facts perhaps justify the highest hope

for future therapeutics." It is of interest that this first bacterial antibiotic effect was observed some five years before Koch was to announce the discovery of tubercle bacillus.

Although Pasteur and Joubert [11] did not pursue their important observations further, other investigators were to make similar observations. Babès,[12] in 1885, demonstrated that certain micro-organisms may produce substances which prevent or inhibit the growth of other bacteria in vivo. In the same year Cantani [13] reported on the treatment of a tuberculous patient with apparently a nonpathogenic organism, designated as Bact. termo, by having the patient inhale the contents of the bacterial culture. He claimed that Bact. termo replaced the tubercle bacillus in the sputum, resulting in the patient's improvement. This would appear to be the earliest use of bacterial inhalation replacement corresponding to the present-day aerosol therapy.

Because of its high incidence and importance, pulmonary tuberculosis was among the first of the bacterial diseases to command attention from the standpoint of chemotherapy. This was enhanced by the ease with which well-controlled experimental tuberculous infections could be produced in experimental animals. As a result of these extensive clinical and experimental investigations, a large number of substances were studied, including synthetic dyes, compounds of iodine, arsenic, copper, gold, creosote, diaminodiphenylsulfone and its derivatives, Promin, Diasone, and Promizole, with varying encouraging results.

Despite the fact that in the past 10 years a number of antibiotic substances have been demonstrated to have an inhibiting effect on the growth of the tubercle bacillus, it was not until 1944 that Schatz, Bugie, and Waksman [14] announced that they had obtained an antibiotic substance they called streptomycin, and later Schatz and Waksman [15] reported that streptomycin exerted a definite bacteriostatic effect on a human strain of tuberculosis. Shortly after, Feldman and Hinshaw [16] demonstrated that streptomycin had a striking therapeutic effect on experimental tuberculosis in guinea pigs. Hinshaw and Feldman * began clinical trials with streptomycin on tuberculous patients in the fall of 1944, and in 1946 Hinshaw, Feldman, and Pfuetze [19] reported their observations and results on 100 cases of tuberculosis treated with streptomycin. They reported striking improvement in five of the seven patients treated for ulcerative lesions of the respiratory tract. These encouraging results led to further enthusiastic clinical investigation, not only to substantiate these findings but also to establish the most optimal nontoxic dosage.

Figi and his associates [20] reported complete cure of a case of papillary tuberculous laryngitis by giving 0.8 to 1 gm. of streptomycin every 24 hours for six weeks. Black and Bogen,[21] in a series of 34 cases of tuberculous laryngitis treated with varying doses ranging from 0.5 to 2 gm. daily, reported 13 completely healed, 17 improved, and 4 unimproved or worse. In 11 of these patients in whom the intramuscular route alone was used, with the total daily dose of 1 gm., 4 showed complete cure and 7 improved. In another series of 30 patients with tuberculous laryngitis treated over a period of one year with only ultraviolet radiation and cautery, voice rest, and general sanatorium care, they found that only 2 appeared healed, 6 improved, and 22 were unimproved or worse. On the basis of these results, they concluded that streptomycin had definite specific value in the treatment of tuberculous laryngitis.

* References 17 and 18.

Withers [22] reported the same encouraging results in a series of 12 patients treated with 1 gm. of streptomycin given daily intramuscularly. All 12 patients showed marked improvement, none remained the same, none grew worse, and in 10 patients the laryngeal lesion was considered completely cured.

O'Keefe,[10] reporting on 27 cases of tuberculous laryngitis treated by various methods, found the use of aerosol alone unsatisfactory and yielded uniformly poor results. The parenteral administration, using 1 gm. per day, resulted in improvement in the majority of the cases, with complete cure of the laryngeal lesions in 6 out of 10 patients. The use of a larger parenteral dosage of 2 gm. per day likewise afforded a high incidence of cure but was also associated with coincident high toxic reactions. He felt that the combination of parenteral and aerosol methods of administration proved most effective in his cases.

Lieberman and Lell [23] likewise reported encouraging results in a series of 37 patients with laryngeal tuberculosis, who were treated with 1 gm. of streptomycin daily intramuscularly over a period ranging from two to three months. They found that 21 improved considerably or were cured, 8 improved moderately, 5 remained unimproved or had a relapse, and 3 died of their advanced pulmonary disease. Like Black and Bogen [21] and Withers,[22] they encountered very little toxic reactions when using 1 gm. daily, as compared with those reported by Hinshaw and Feldman,† Brown and Hinshaw,[24] and Hinshaw, Feldman, and Pfuetze,[19] who used much larger doses (2 to 3 gm. daily) in their early investigative work.

In a combined report of the Army, Navy, and Veterans Administration [25] the toxic reactions encountered in 233 patients followed on a daily dose of 1.8 gm. for 120 days were stressed. In this group tinnitus was present in 46% of the cases, vertigo in 92%, and hearing decreased in 2% of the cases. Deafness was temporary and seemed reversible one month after use of the drug was discontinued.

McDermott [26] placed greatest emphasis on the neurological reactions but also listed a histaminic-like reaction and irritation at the injection site, due to impurities in earlier lots of the drug. He classified the anaphylactic manifestations, such as fever, dermatitis without fever, eosinophilia without eruption, as not serious. Renal complications he attributed to kidney disturbances already present in the particular patient in question. Under the neurological reactions he discussed in detail vestibular dysfunction and deafness. The appearance of vestibular dysfunction varied with dosage, namely, the higher the dosage the earlier the possible onset, and the same applied to deafness.

Brown and Hinshaw,[24] in reporting on 23 cases of tuberculosis of all types, with reference to the influence of streptomycin on the eighth nerve, also found low incidence of loss of hearing when the lower doses of streptomycin were used. These investigators also felt that the lesion was peripheral rather than central. Winston and his associates,[27] however, obtained evidence of damage to the central portion of the vestibular apparatus when streptomycin was administered to cats. They also state that their experimental findings did not rule out the possibility of concomitant damage to the peripheral end-organs of the vestibular apparatus.

In view of these favorable results obtained by other investigators, treatment of patients with laryngeal tuberculosis was begun in 1948, when the price of strepto-

† References 17 and 18.

mycin became economically possible for the patients to afford a prolonged course of treatment. Since the price of streptomycin in the beginning was quite exorbitant, the number of patients treated in the first part of the study was of necessity, unfortunately, limited to those who could afford to pay for it. With the subsequent reduction in the price of the drug, it became available to a larger number of deserving patients.

This study covers a series of 56 patients with proved laryngeal tuberculosis of varying degrees of involvement, associated with definite distressing symptoms of hoarseness, local discomfort, dysphagia or odynophagia, and weight loss.

The parenteral method of administration of 1 gm. of streptomycin, divided into two equal daily doses, was used in this study. The nature of the laryngeal pathology

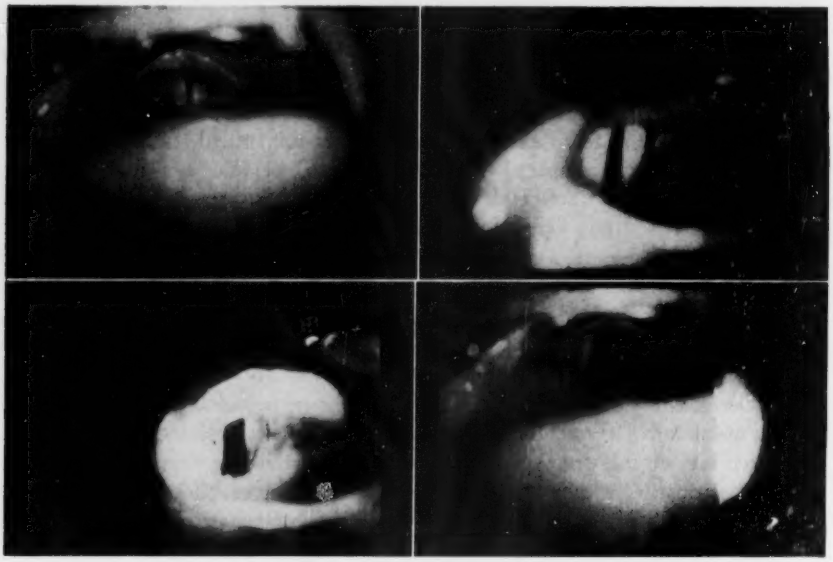

Fig. 1.—Views of normal larynges in different phases of respiration.

was ascertained by careful examination of the larynx by mirror laryngoscopy in the majority of the cases and by direct laryngoscopy in some of the patients in whom it was difficult to clearly visualize the larynx by mirror examination or because of the necessity of taking a biopsy specimen for differential diagnosis. An accurate record was maintained of the nature, location, and degree of involvement, and on the basis of these findings the patients were classified according to the four types previously described, depending upon the degree of laryngeal disease. None of the patients having the minimal changes described in Type I received streptomycin therapy, since these patients did not have sufficient abnormal changes or discomfort to justify the use of the drug. However, all patients who demonstrated the laryngeal abnormalities described in Types II, II, and IV were treated with streptomycin, with careful periodic observations of the larynx to establish the degree of benefit produced by the drug. Photographic records in Kodachrome were obtained before

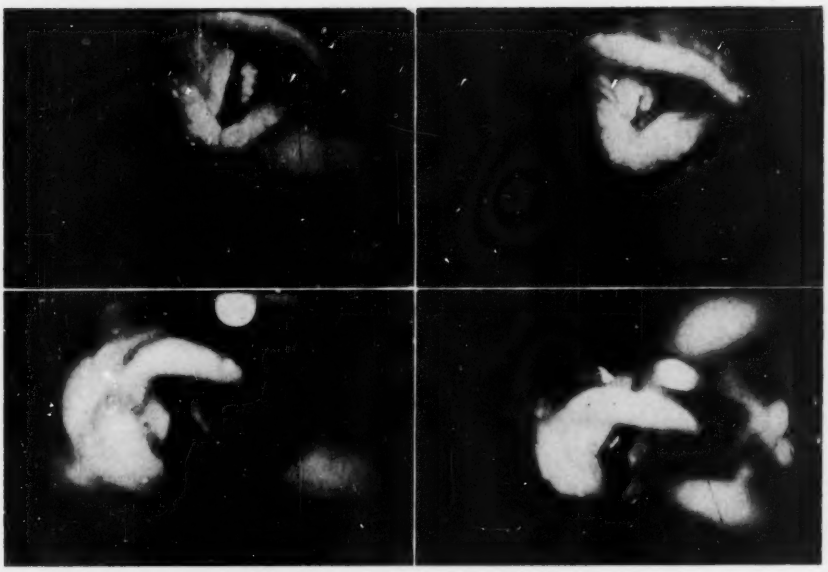

Fig. 2.—Views of larynges showing early tuberculous involvement of vocal cords: Type II.

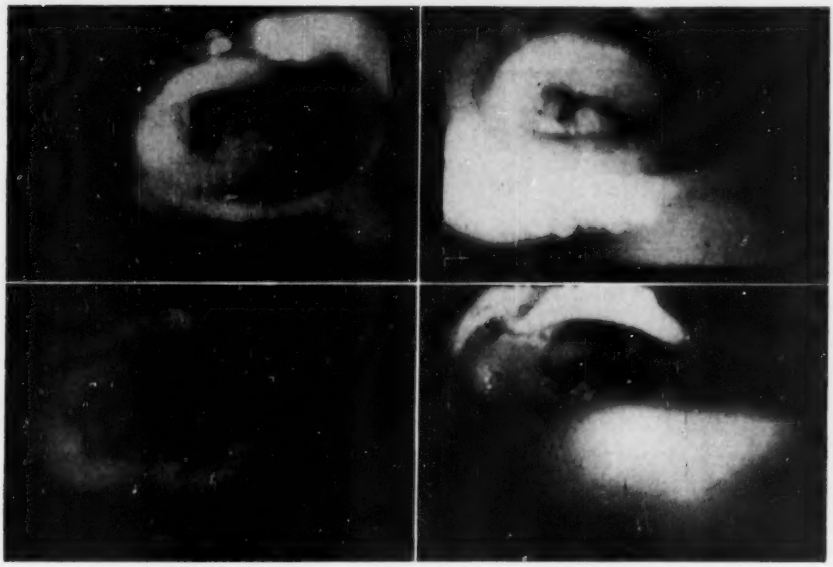

Fig. 3.—Views of larynges showing more advanced tuberculous ulceration: Type III.

the start and on termination of treatment in many of these cases so that the changes could be evaluated without the element of human error. The results obtained in some of these patients were also recorded on a motion picture film.

In all, 56 patients were studied in this series, and the course of treatment and observation of these patients ranged from 28 to 122 days. All these patients had preliminary hearing and neurologic tests as a base line for any existing abnormality

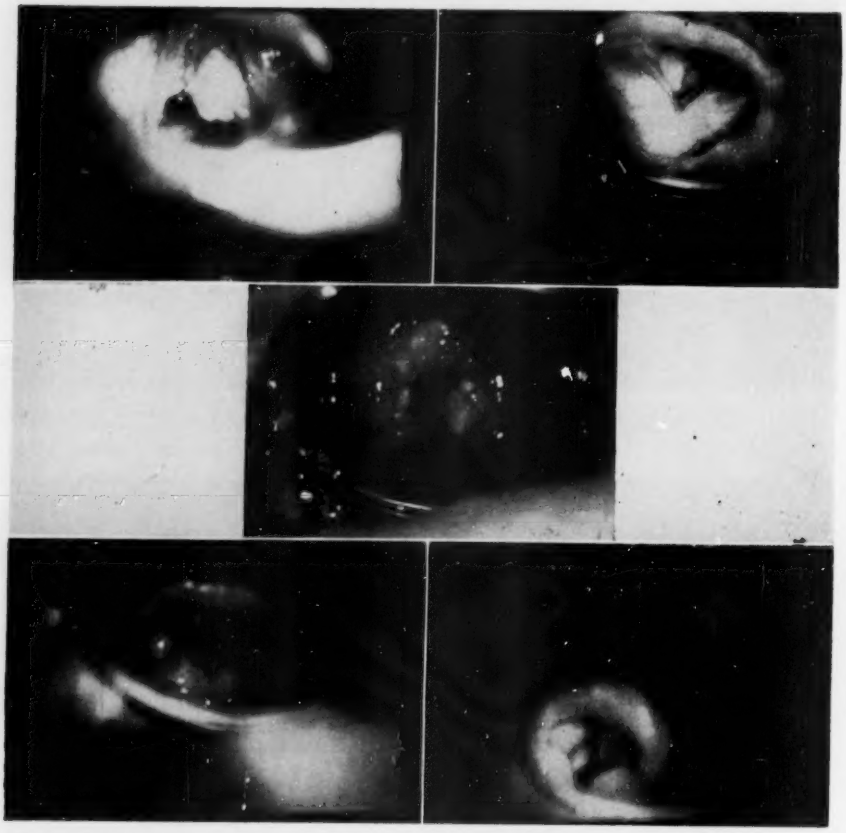

Fig. 4.—Views of larynges showing far advanced tuberculous involvement with destructive changes: Type IV.

as a means of comparison for any complications which might develop as a result of the administration of the drug itself. No financial aid from any grant was received in this study.

Table 9 shows the number of patients treated according to type of laryngeal involvement and the results that were obtained (the same classification described earlier in this paper was used).

Analysis of Table 9 shows that most of the cases treated fell under Type II. This group of cases also showed the most favorable response to streptomycin

therapy, unquestionably because of the fact that the laryngeal lesions in this group were early and treatment was begun before the serious destructive changes of the laryngeal structures had occurred. Of the 33 cases in this group, 28 were cured, and the other 5 showed definite improvement, although they were never completely healed, in spite of prolonged treatment. The results obtained in the group of Type III were not as striking. Here, of the 16 patients, only 7 were cured, 6 improved, and 3 showed no evidence of improvement. The results obtained in the group of Type IV were more discouraging. Of seven patients in this group, only one was cured, three showed slight improvement, and three showed no improvement whatsoever.

The results obtained in Types III and IV clearly show that the use of streptomycin in the treatment of the advanced cases with severe damage of the laryngeal structures is less effective than when used in the earlier cases before the severe infiltrative and destructive changes have occurred. Thus the effective treatment of laryngeal tuberculosis resolves itself to a problem of early and accurate diagnosis of the laryngeal complications so that treatment may be instituted before severe damage has occurred to the mucous membrane and underlying structures of the larynx.

TABLE 9.—*Results of Streptomycin Therapy in 56 Patients with Laryngeal Tuberculosis*

	Patients			
Laryngeal Involvement, Type	Total No.	Cured	Improved	Unimproved
Type II	33	28	5	0
Type III	16	7	6	3
Type IV	7	1	3	3

Although streptomycin, when properly used, has proved a wonderful aid in the treatment of laryngeal tuberculosis, it should not be expected to have the power of regenerating destroyed tissues, such as amputation of the epiglottis and far advanced ulcerative changes in other areas of the larynx.

On the other hand, even in these far advanced cases, one occasionally obtains results far beyond one's fondest expectations, so that the hopeless nature of the laryngeal damage should not deter one from the use of streptomycin, if for nothing more than palliation.

The detailed information on the duration of the treatment, the results obtained, and the complications encountered in this series of patients are shown in Table 10.

Streptomycin was the only drug added to the previously established routine treatment of pulmonary tuberculosis in these 56 cases.

In a review of the complications encountered in this group of cases, one fact seems apparent, namely, that the longer the treatment was prolonged the more likely the development of some abnormal reaction, in spite of the fact that the dosage was only 1 gm. (divided into two equal parts) daily. Of additional interest was the observation that the patients who were to respond to streptomycin therapy began to show definite signs of improvement very early in the course of the treatment.

A clear knowledge of the nature of the laryngeal involvement according to the above types has afforded a better understanding why streptomycin is more effective in the earlier types of lesions and less so where destructive changes have occurred.

TABLE 10.—*Clinical Data on 56 Laryngeal Tuberculous Patients Treated with Streptomycin*

Case No.	Age, Yr.	Race	Sex	Duration of Treatment, Days*	Laryngeal Results	Complications
					Type II	
1	18	White	F	28	Partly improved	Blurring vision Marked dizziness Treatment stopped
2	35	White	F	62	Cured	Mild impaired hearing
3	57	Negro	M	72	Cured	None
4	38	White	M	84	Cured	Mild dizziness at end of treatment
5	33	White	F	48	Cured	None
6	28	White	F	76	Cured	None
7	53	Negro	M	92	Cured	Mild impaired hearing
8	44	White	F	54	Partly improved	Blurring vision Dizziness; treatment stopped
9	32	White	M	72	Cured	None
10	54	Negro	M	84	Cured	None
11	37	White	M	96	Cured	Mild impaired hearing
12	29	Negro	F	74	Cured	None
13	36	Negro	F	86	Cured	None
14	46	White	M	78	Cured	None
15	28	White	M	46	Cured	Slight dizziness; no impaired hearing
16	38	Negro	M	60	Partly improved	Slight vertigo Slight impaired hearing
17	51	White	F	78	Cured	None
18	47	White	M	36	Partly improved	Treatment discontinued; marked vertigo
19	66	White	M	46	Cured	None
20	57	White	F	56	Cured	None
21	52	White	M	27	Partly improved	Treatment discontinued; slight impaired hearing; marked dizziness
22	54	White	M	62	Cured	None
23	46	White	F	39	Cured	None
24	43	White	F	48	Cured	None
25	24	Negro	F	68	Cured	None
26	52	White	M	62	Cured	Mild vertigo at end of treatment
27	55	White	M	73	Cured	None
28	43	White	M	56	Cured	Slight impairment of hearing
29	39	Negro	M	78	Cured	None
30	33	Negro	F	68	Cured	Slight vertigo; no loss of hearing
31	32	White	F	90	Cured	Temporary loss of hearing
32	47	White	M	56	Cured	None
33	38	White	F	48	Cured	None
					Type III	
1	24	White	M	92	Cured	Developed dermatitis toward end of treatment
2	36	Negro	F	110	Partly improved	Beginning loss of hearing; treatment stopped
3	42	White	F	76	Cured	None
4	54	Negro	M	48	Cured	Mild loss of hearing
5	46	Negro	F	96	Slightly improved	Developed definite impaired hearing Treatment stopped
6	26	White	F	68	Cured	None
7	38	Negro	M	84	Partly improved	Marked vertigo; treatment stopped
8	28	Negro	F	54	Cured	None
9	36	White	F	88	Slightly improved	Severe vertigo; blurring vision; treatment stopped
10	50	White	M	65	Cured	None
11	42	White	M	90	No improvement	Marked vertigo; treatment stopped
12	22	White	F	48	Cured	None
13	34	Negro	M	86	Partly improved	Beginning loss of hearing; treatment stopped
14	51	White	M	102	Partly improved	Severe dermatitis; treatment stopped
15	30	White	F	64	Partly improved	Severe vertigo; treatment stopped
16	44	Negro	M	78	Partly improved	Beginning loss of hearing; treatment stopped
					Type IV	
1	32	White	F	112	No improvement	Vertigo and impaired hearing at end of treatment
2	26	Negro	F	96	No improvement	Patient refused further treatment
3	42	White	M	74	No improvement	Marked vertigo; loss of hearing; treatment stopped
4	23	White	F	120	Slightly improved	Dermatitis at end of treatment
5	37	White	M	102	Cured	Slight blurring vision; slight vertigo toward end of treatment
6	41	White	M	94	Slightly improved	Marked vertigo; treatment stopped
7	35	White	M	68	Slightly improved	Definite loss of hearing; treatment stopped

* Treatment was 1 gm. of streptomycin daily.

CONCLUSIONS

1. Laryngeal complications of pulmonary tuberculosis should be recognized early so that therapy may be instituted before severe damage to the laryngeal structures has occurred.

2. The diagnosis of laryngeal tuberculosis should be made not entirely from symptoms of hoarseness or local discomfort but by actual examination of the larynx. This may often be accomplished by mirror laryngoscopy. In questionable cases a direct examination with a biopsy of tissue for histological examination may be necessary.

3. The incidence of laryngeal tuberculosis in two different groups of cases, totaling 803 males and 686 females suffering from pulmonary tuberculosis, was studied and tabulated in detail.

4. The laryngeal lesions were classified into four types, according to the nature and degree of involvement of the laryngeal structures, which subsequently proved very useful in the classification of the 56 patients with laryngeal tuberculosis treated with streptomycin.

5. The results of streptomycin therapy of 56 cases of laryngeal tuberculosis subdivided into three different types, according to the nature of the laryngeal involvement, are reported.

6. This study revealed that streptomycin was most effective in the early types of lesions, less so in the more advanced types, and ineffective in the cases with destructive changes in the laryngeal structures.

7. Even when 1 gm. daily was administered, toxic reactions of a varying degree are more likely to occur when the drug is used over a prolonged period of time.

8. In spite of these possible toxic reactions, streptomycin still remains the most effective drug in the treatment of early laryngeal tuberculosis.

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HOW TO HANDLE ACUTE NASAL INJURIES

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IT HAS become apparent that for the past decade the doctor has been seeing and treating an increasing number of injuries to the nose. The causes of these injuries are numerous and include automobile and industrial accidents, athletic injuries, injuries to children at play, and even birth injuries.

Many problems in diagnosis and treatment have arisen, and a group of rhinologists from all sections of the country have studied these and associated problems in courses given under the direction of Dr. Maurice Cottle, of Chicago. They have learned that newer concepts of nasal physiology, and the consequent surgical and medical handling of the acutely injured nose, present a very changed picture from the older methods of dealing with these problems. Now the rhinologist must equip himself to deal with the injured nose in the light of this modern knowledge, or he fails in his role as doctor to offer the best chances for restoration of function and appearance to the patient.

The day has passed when the doctor should try to deal with all acute injuries to the nose as a routine office procedure. It is our feeling that when dealing with most acute injuries of the nose, the rhinologist should be prepared to finish any problem that presents itself during the operation. This is a must, if he hopes to obtain adequate correction and restoration of the nasal function. It may mean doing a submucous resection. It may mean doing an open reduction under direct visual inspection. It may mean uncovering the entire bony pyramid or doing a rhinoplasty in combination with any of the above-mentioned procedures. In short, let us repeat, it means being able to deal with any problem arising at the time of surgery. No longer should the rhinologist say, "Wait until the external swelling goes down." If this swelling is due to a hematoma, it is surgically drained. This is a very practical procedure under local anesthesia and has been greatly facilitated by the use of hyaluronidase. No longer should he try to realign or reposition the acutely fractured or dislocated septum with the Asch forceps and then say to himself, "Now I will wait and see and do a secondary submucous resection if it is deemed necessary." No longer should he be misled into cocainizing the acutely injured nose in the office and then try to do an inadequate reduction and repositioning of the various structures. If he will equip himself with a modern armamentarium of not only instru-

ments but also a good knowledge of nasal physiology and anatomy, he will then be able to handle the acutely injured nose properly. An outline of some of the problems which daily confront the rhinologist and a brief resumé of how he should be prepared to handle them in the light of more modern knowledge are herewith presented.

The examination of a nose which has suffered recent injury requires much more than external examination by vision and palpation. Often there is so much soft tissue swelling and ecchymosis that accurate evaluation by vision and palpation is impossible. X-rays frequently do not show the damage present.

To examine a nose properly, there should be facilities for complete anesthesia, and a suction apparatus should be available. Preexamination sedation may be helpful. Good illumination for internal examination of the nose, either by head mirror or head light, should be used. If there is much soft tissue swelling, infiltration with procaine and hyaluronidase solution will reduce this handicap. Visual examination and palpation of the bony and cartilaginous vault can then be reasonably accurate. Mucosal anesthesia is obtained by using cocaine flakes on epinephrine-moistened cotton. Internal examination and evaluation is not attempted until the nose has been cleansed of clots and debris. Look for evidence of hematoma in the vestibule. Also look for hematoma high in the nose, under the nasal bones and cartilages. Look for evidence of septal injury, which may be indicated by a tear in the mucosa. Look for fragments of nasal bone which may have lacerated the mucosa.

Examination of the nose of an injured child is extremely difficult. The principles outlined above for the adult, namely, anesthesia, elimination of swelling, external visualization and palpation, and internal visualization, still apply. Complete general inhalation anesthesia is recommended when necessary.

Injuries of the nose are divided into five types: contusions, lacerations, hematomas, fractures and dislocations of the septal cartilage, and fractures of the nasal bones, with or without dislocation.

CONTUSIONS

The symptoms of contusion are similar to those of fracture. There may be ecchymosis of the nose and eyes, edema of the nasal dorsum, and tenderness to palpation. The essential differentiation may be made by using hyaluronidase in the anesthetizing solution. This causes a rapid disappearance of the swelling and helps to rule out a nasal fracture. Following this, a tape dressing is placed on the nose, and cold applications are used for 24 hours.

LACERATIONS

Lacerations of the nose are often associated with more severe injuries. The treatment consists of careful cleansing and minimal débridement of the injured tissues under adequate anesthesia. The skin margins are carefully approximated with fine sutures placed closely together. Fractures should be reduced, and lacerations of the septum should be sutured before repairing the skin. The nose should be packed lightly with cod-liver-oil gauze, externally taped, and dressed with a Stent dental compound. A pressure dressing to the eyes is of value in preventing swelling and promoting healing. Antibiotics and, if deemed necessary, protection against tetanus and gas bacillus should be given.

HEMATOMAS

A hematoma is more likely to occur either in the septum or between the upper lateral cartilage and the nasal bone. A hematoma of the septum is usually secondary to a laceration, fracture, or dislocation of the septal cartilage. The septal mucosa appears blue and often is so swollen that it occludes both nasal passageways. This condition usually occurs several days after the injury. If prompt attention is not given, absorption will occur, involving the septal and upper lateral cartilages, with subsequent saddle deformity of the nasal dorsum. The septal hematoma should be incised, drained, and the nose packed lightly with cod-liver-oil gauze. Often it is necessary to do a septal operation at the same time. In children, if saddling occurs, it should be repaired in six to eight months by cartilage implants in the septum and on the dorsum. These cartilage implants may have to be repeated to allow for growth of the nose until a permanent cancellous bone graft can be used. In adults, after an adequate waiting period, the defect should be repaired by an implant from the iliac crest.

When hematoma occurs between the upper lateral cartilage and the nasal bones, a bluish discolored swelling is seen high inside the nose, between the septum and the lateral wall. There should be prompt incision and drainage in the intercartilaginous area, and the nose is then packed, taped, and splinted. Antibiotics are given. If this condition is left uncorrected, there will occur a separation of the lateral cartilage from the nasal bone, with subsequent collapse of the cartilaginous vault. A twisting of the upper lateral cartilage or, sometimes, an absorption of the upper lateral cartilage can also occur.

FRACTURE OR DISLOCATION OF THE SEPTAL CARTILAGE

Injuries of the septal cartilage are often associated with nasal fractures. The reason for this is that, with a fracture of the nasal bones, there is a downward displacement with subsequent buckling or fracture of the cartilage. Often the diagnosis is not made until the patient is anesthetized and examined in surgery. The repair of the septal injuries is by open reduction. Through a hemitransfixion incision at the caudal end of the septum, both mucoperichondrial flaps are elevated and the cartilage and bones inspected. The small fragments of cartilage and bone are removed or repositioned. At the same time, a depressed fracture of the nasal bones can be reduced by elevation through the septal space. The nose is packed, taped, and splinted. Failure to open the septum may result in subsequent scar-tissue formation, retraction, and then twisting of the cartilaginous dorsum. Thus the repair of old injuries may require a combined septal reconstruction and rhinoplasty.

FRACTURE OF THE NASAL BONES

The symptoms of a nasal fracture are hemorrhage, deformity, swelling, pain, nasal obstruction, and ecchymosis around the nose and eyes. An x-ray may be helpful in nasal fractures but is essential if there is a possibility of facial bone fractures. The accurate diagnosis is made in surgery. Reduction of a simple fracture is by intranasal elevation with a blunt instrument. However, many cases need to be reduced, as described in the treatment of septal injuries. In a severe depressed fracture of the nasal bones, an open reduction by the rhinoplastic approach is necessary. A depression of the cartilaginous vault should be repaired by a cartilage graft

to the nasal dorsum. In compound fractures, one can use a laceration in the skin, to help pry the bones into position. If the injured person has other deformities, such as a hump or bulbous tip, these conditions may be repaired at the same time the fracture is reduced. Following repair, the nose is packed, taped, and splinted.

PRECAUTIONS

Improperly cared for fractures in children often result in great deformities as the children grow older.

To minimize unsightly scars and deformity, all lacerations should be meticulously repaired.

A hematoma in the septum or in the region of the upper lateral cartilages usually results in a saddle deformity.

If an open reduction of a septal fracture or dislocation is not done, the subsequent scarring and contraction often cause a twisting of the cartilaginous dorsum.

Every nasal injury has a downward displacement.

SUMMARY

Critical evaluation of past practices used in handling nasal injuries has led a group of rhinologists associated with Dr. Maurice Cottle to institute more complete and more satisfactory methods of analyzing and handling the problem. The examination to establish diagnosis is done best in the operation room, where all facilities are available. General anesthesia is recommended for examination of children. The common injuries of the nose are described and their treatment outlined.

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Case Reports

ESOPHAGORESPIRATORY FISTULAE

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ESOPHAGORESPIRATORY fistulae are uncommon. They usually form a communication between the esophagus and trachea, and less frequently they enter a bronchus or the pleural cavity. Esophageal fistulae may also terminate in the mediastinum, pericardial cavity, or skin.

The congenital type occurs with or without esophageal atresia or stenosis and usually communicates with the trachea. Esophagorespiratory fistulae in adults may be congenital. The etiology of the acquired fistulae, in their probable order of frequency, is as follows: 1. Carcinoma of the esophagus. 2. Trauma due to ingested foreign bodies, caustics, instrumental dilatation, and crushing injuries of the thorax. 3. Infections of the esophagus, trachea, bronchi, pleura, or mediastinum, due chiefly to tuberculosis and syphilis. Pathogenic organisms, fungi, and nonspecific infections may also be the cause. 4. Unknown etiology. 5. Esophageal traction diverticula. These may be multiple, are usually not more than 2 cm. in diameter, and are generally located in the middle third of the esophagus. They are believed to be produced by traction on the esophageal wall by scar tissue about inflammatory bronchial or mediastinal adenopathies. They are usually asymptomatic, but may be complicated by stasis, infection, and fistula. 6. Broncholithiasis. 7. Aneurysm. 8. Esophagomalacia.

The congenital fistulae usually manifest their presence early, while the acquired may be present for years before producing symptoms. The latter may be due to a small slit or valve-like opening in the esophagus or to closure of the tract by contractions of the esophagus, and possibly of the trachea and bronchi, during deglutition. The symptoms and signs depend on the etiology, primary pathologic changes, and site of the fistula. Regurgitation, often attributed to nervousness, may be the only complaint. Difficulty in swallowing of liquids is usually the initial symptom. Dysphagia increases, and later there are strangling, cough, and often dyspnea during meals. Swallowing in the dorsal recumbent position may minimize these symptoms. Sputum mixed with food is often raised in increasing amounts. It may contain purulent material and blood. Substernal or referred pain to the shoulders may be present. Food intake may be reduced to a minimum, with resulting loss of weight.

Complications include chronic cough, recurring pneumonia, bronchiectasis, pulmonary abscess and gangrene, mediastinal abscess, fatal hemorrhage, and asphyxial death if the trachea is suddenly blocked.

A carefully taken history and properly interpreted findings of the physical, roentgenoscopic, roentgenographic, and endoscopic examinations are necessary for

From the Veterans Administration Hospital.

diagnosis and thorough evaluation of the extent of the pathologic changes. Iodized oil is preferable to barium sulfate mixtures for roentgen examination because of possible lung irritation by the latter. A right anterior oblique x-ray view may be adequate. However, other positions and the Valsalva maneuver may be required to demonstrate the fistula.

The prognosis depends on the etiology, size of the tract, and complications.

Treatment varies according to the primary disease, complications, condition of the patient, and extent of the pathologic changes. There is rarely closure and healing following rest of the esophagus and eradication of infection. Small uncomplicated fistulae may be closed by cauterization. Closure of the orifices and excision of the tract may be the procedure of choice. Resection of the lung may be required if there are pulmonary complications.

REPORT OF A CASE

The patient, a male Negro, 38 years of age, weighing 158 lb. (71.8 kg.), was originally hospitalized for paranoid-type schizophrenia, and was incompetent. A small amount of bright blood was noticed on his bed sheet on Sept. 16, 1953. It was not possible to ascertain whether this resulted from cough or from vomiting. There were no other signs or symptoms. Temperature, pulse, and respiration were normal. Physical and sputum examinations and tests for syphilis were negative. Roentgen examination of the gastrointestinal tract revealed that a small amount of the diagnostic opaque material entered a moderate-sized branch of the right main bronchus through an opening in the esophagus at about the level of the eighth dorsal vertebral body. The fistula and the bronchus with its basal ramifications were subsequently well outlined with iodized oil. There was no regurgitation or cough during these procedures. No residual opaque material was observed in an examination made one week later. Other laboratory studies did not contribute anything toward diagnosis.

A review of the past history revealed that on Aug. 31, 1951, the patient complained of generalized aching, had a temperature of 102.6 F., and pulse and respiratory rates of 130 and 24 per minute respectively. Rales were heard on the right side. A roentgenogram of the chest showed pneumonic consolidation of the right lung, which was most marked mesially. He vomited once on June 2, 1950, July 18, 1950, and again on Sept. 30, 1953. At least one of these attacks followed ingestion of a large amount of food. Temperature, pulse, and respiration were normal during these episodes, and there were no other signs or symptoms. His appetite was usually good. During the past 10 years, his weight averaged between 155 and 162 lb. (70.0 to 73.6 kg.).

He was transferred to the Veterans Hospital, Nashville, Tenn., for treatment. Physical examination and laboratory studies made there were likewise essentially negative. A roentgen study of the esophagus revealed no signs of a fistula until the Valsalva maneuver was used. The accompanying figure shows the fistula, distorted bronchi, and a cystic area in the superior segment of the right lower lobe. Bronchoscopic and esophagoscopic examinations were essentially negative. The latter examination was repeated preceding the operation, and what was thought to be the opening of the fistula was seen at a distance of 36 cm. from the incisor teeth. Operation revealed that the esophagus was adherent to the medial basal segment of the lower lobe just superior to the right inferior pulmonary vein. Palpation gave an impression of lung abscess in the superior segment of the right lower lobe. The wall of the esophagus surrounding the fistula appeared normal. The right lower lobe was removed. The esophageal and bronchial stumps were closed, and a tracheotomy was done. Recovery was uneventful.

The gross specimen showed an opening in the region of the superior segment, which continued into the lung substance as a fistula. It entered a segmental bronchus and communicated with a cystic space in the superior segment.

Microscopic examination of the sections revealed that the tract was lined with stratified squamous epithelium devoid of a smooth muscle layer and terminated in a bronchus. The wall

of the parenchymal cyst was lined with tall columnar epithelium, with a submucosal fibrotic zone diffusely infiltrated with plasma cells and lymphocytes. An ectatic bronchiole was noted. There was fibrous thickening of the pleura, and the underlying parenchyma showed alveolar epithelium composed of flat thick cells, fibrosis, and diffuse chronic inflammatory-cell infiltration consisting chiefly of lymphocytes. The small bronchi and their branches showed submucosal fibrosis and diffuse mononuclear cell infiltration. The diagnosis was esophagobronchial fistula, bronchiectasis, and chronic interstitial pneumonitis.

Roentgenograms of the chest made during a period of years prior to the recent illness did not show the cystic area described above. There is no definite evidence to indicate that it was congenital and enlarged later. All possibilities were considered in attempting to ascertain the probable cause of the fistula. However, it must be concluded that the etiology is unknown.

Oblique view shows the esophagus, the fistula, distorted bronchi, and the cystic area in the superior segment of the right lower lobe.

SUMMARY AND CONCLUSIONS

Esophagorespiratory fistulae are rare. Communication with a bronchus is less frequent than with the trachea.

Etiology, symptoms, diagnosis, and treatment are presented.

The acquired type of fistula in particular may be asymptomatic for years. Regurgitation may be the only complaint and is often attributed to nervousness. Special procedures may be necessary to demonstrate the fistula.

A case report with operative and histologic findings is included.

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SPONTANEOUS EXPULSION OF NONOPAQUE FOREIGN BODY IN TRACHEOBRONCHIAL TREE

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THE DIAGNOSIS of foreign bodies in the tracheobronchial tree is made from the history, radiological findings, and physical examination. There are times, however, when reports on physical findings and radiological findings, if not interpreted properly, can be misleading unless the bronchoscopist checks and interprets

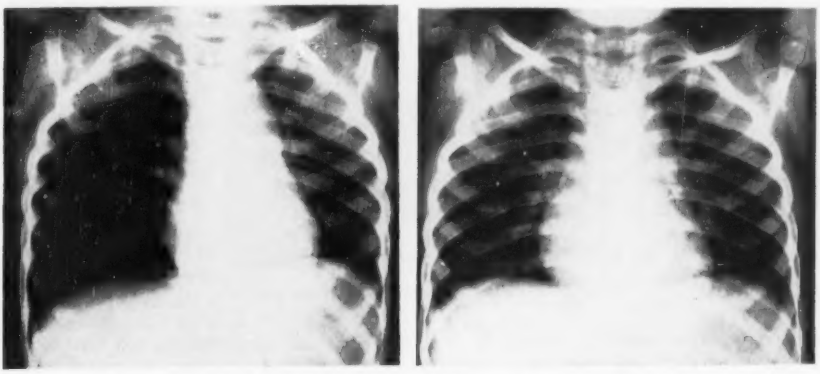

Fig. 1.—Roentgenogram before expulsion of the foreign body. Note the enlargement of the right hemithorax, the widened interspaces, the hyperventilation of the right lung, and the shift of the heart to the left—all characteristic findings of obstructive emphysema.

Fig. 2.—Roentgenogram after expulsion of the foreign body. Note the restitution to normal.

the findings. Errors in diagnosis occasionally occur on the part of the examiners, sometimes due to unfamiliarity in what to look for in a given case. Therefore herewith is presented a case in kind to illustrate this pitfall in diagnosis.

REPORT OF CASE

H. E. (A-21650), a 4½-year-old boy, was admitted to the hospital on the morning of Oct. 1, 1953, with a bizarre history of having accidentally swallowed or aspirated a portion of a plastic toy that he had been sucking upon that morning at home. The child immediately developed a dry and nonproductive cough. This point was brought out by the mother. Further history revealed that an older brother had playfully attempted to remove this toy from his brother's mouth. Refusing to release it, the younger boy bit down upon it, and, in so doing, the plastic toy broke; a portion was recovered by the older boy, while the remainder was either swallowed or aspirated by the patient.

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This case report was prepared under the supervision of Morris S. Bender, M.D., Director of the Department of Otolaryngology, Queens Hospital Center.

Physical Examination.—On inspection the child was in no apparent distress, and his color was good; however, there was a slight overexertion of the alar nasae movements. On auscultation of the chest there was a "slapping sound" heard over the trachea when the patient was in the sitting-up position. The lung areas on the anterior and posterior chest walls revealed diffused, high-pitched, dry rales throughout all fields. All other physical examination was normal. The pulse was 120 per minute. Respirations were 32 per minute, and the heart sounds were normal throughout.

Roentgenological Findings.—Initial wet-reading examination revealed no evidence of an opaque foreign body. However, the right lung showed considerable emphysema and hyperaeration. The heart and mediastinum appeared shifted slightly to the left. The entire right side was larger than the left. The findings were compatible with an obstructive type of emphysema.

From the physical and roentgenological findings, there was evidence that a nonopaque foreign body was present in the tracheobronchial tree, acting as a "check valve" in the right main stem bronchus.

During the process of preparing for bronchoscopy, the child was seized with a violent coughing spasm and coughed up the foreign body. It was a piece of plastic material about 4.5 cm. in length and 0.5 cm. in diameter, well rounded at one end (Fig. 3). Another x-ray was taken, and the lungs then showed normal aeration in both fields. The dry cough present upon admission

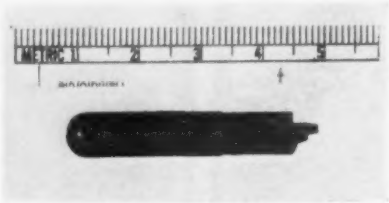

Fig. 3.—Plastic nonopaque foreign body.

disappeared. The respiration rate was 20 per minute, pulse rate 120 per minute, and heart sounds normal. The child was discharged from the hospital the following day. Figures 1 and 2 demonstrate the lung findings prior to and immediately after the spontaneous expulsion of the nonopaque foreign body from the tracheobronchial tree.

COMMENT

In cases of suspected aspiration of nonopaque foreign bodies, even though the object may not be seen upon the x-ray film, the x-ray should be carefully evaluated, especially the trapping of air and any other changes in the lung fields. X-rays should be taken upon both inspiration and expiration. In this case, the child did not appear to be in any immediate acute respiratory distress upon admission to the hospital or during his stay. X-ray findings should be carefully studied and evaluated by the bronchoscopist, especially since the shadow of a nonopaque foreign body does not present itself. All one can go by is definite pathological lung changes that are elicited by both physical findings and roentgenological examination.

SUMMARY

A case is reported of a nonopaque foreign body present in the right main stem bronchus, suggested by the signs of obstructive emphysema evident on the roentgenogram. The foreign body was expelled spontaneously.

This work was carried out in cooperation with the Department of Roentgenology, Queens General Hospital.

Special Reports

HEARING AIDS ACCEPTED BY THE COUNCIL ON PHYSICAL MEDICINE AND REHABILITATION OF THE AMERICAN MEDICAL ASSOCIATION

AS OF AUG. 1, 1954

Acousticon Models A-17, A-180, & A-185
Mfr., Dictograph Products Inc.
95-25 149th St.
Jamaica 35, N. Y.

Audiotone Models 11 & 15
Mfr., Audio Company of America
5305 N. 6th St.
Phoenix, Ariz.

Audivox Models Super 67 & 70
Mfr., Audivox, Inc.
123 Worcester St.
Boston 18

Aurex Models L & M
Mfr., Aurex Corporation
1117 N. Franklin St.
Chicago 10

Beltone Mono-Pac Model "Lyric"

Beltone Mono-Pac Model M

Beltone Mono-Pac Model "Rhapsody"
Mfr., Beltone Hearing Aid Co.
2900 W. 36th St.
Chicago 32

Cleartone Model 700
Mfr., American Sound Products, Inc.
1303 S. Michigan Ave.
Chicago 5

Dahlberg Junior Model D-2

Dahlberg Model D-3 (Tru-Sonic)

Dahlberg Model D-4 (Tru-Sonic)
Mfr., The Dahlberg Company
Golden Valley
Minneapolis 22

Fortiphone Models 19LR, 20A, 21C, & 22
Mfr., Fortiphone Limited
Fortiphone House
247 Regent St.
London, W.1, England

Distr., Anton Heilman
75 Madison Ave.
New York 17

Gem Model V-60
Mfr., The Gem Ear Phone Co., Inc.
50 W. 29th St.
New York 1

Goldentone Models 25, 69, & 97
Mfr., Johnston Hearing Aid Mfg. Co.
708 W. 40th St.
Minneapolis 8

Distr., Goldentone Corp.
708 W. 40th St.
Minneapolis 8

Maico Maxitone

Maico Model J

Maico Top Secret Model L
Mfr., The Maico Company, Inc.
21 N. 3rd St.
Minneapolis 1

Micronic Model Mercury
Mfr., Audivox, Inc—Successor to Western Electric Hearing Aid Division
123 Worcester St.
Boston 18

Microtone Models T-10 & T-612
Mfr., The Microtone Corporation
758 S. Mississippi River Blvd.
St. Paul 1

Normatone Model C

Normatone Model D-53
Mfr., Johnston Hearing Aid Mfg. Co.
708 W. 40th St.
Minneapolis 8

Distr., Normatone Hearing Aid Co.
22 E. 7th St.
St. Paul 1

Otarion Models B-15 & B-30

Otarion Models F-1 & F-3

Otarion Model H-1, Custom "5"
Mfr., Otarion, Inc.
185-7 Ashford Ave.
Dobbs Ferry, N. Y.

Paravox Model D (Top-Twin-Tone)

Paravox Model J (Tiny-Myte)
Mfr., Paravox, Inc.
2056 E. 4th St.
Cleveland 15

Radioear Model 62 Starlet

Radioear Model 72

Radioear Model 82 (Zephyr)
Mfr., E. A. Myers & Sons, Inc.
306 Beverly Rd.
Mt. Lebanon
Pittsburgh 16

Distr., Radioear Corporation
306 Beverly Rd., Mt. Lebanon
Pittsburgh 16

Silvertone Models H-16, J-92, & P-15
Mfr., Johnston Hearing Aid Mfg. Company
708 W. 40th St.
Minneapolis 8

Distr., Sears, Roebuck & Co.
925 S. Homan Ave.
Chicago 7

Solo-Pak Model 99
Mfr., Solo-Pak Electronics Corp.
Linden St.
Reading, Mass.

Sonotone Models 910, 920, 925, 940, 966, 977, & 988
Mfr., Sonotone Corporation
Elmsford, N. Y.

Televox Model E
Mfr., Televox Mfg. Company
1307 Sansom St.
Philadelphia 7

Telex Models 99, 200, 400, 500, 952, 953, & 1700
Mfr., Telex, Inc.
Telex Park
St. Paul 1

Tonamic Model 50
Mfr., Tonamic, Inc.
12 Russell St.
Everett 49, Mass.

Tonemaster Cameo Model
Mfr., Tonemaster Mfg. Co.
128 S. Monroe St.
Peoria, Ill.

Unex Midget Models 95 & 110

Unex Models 200 & 230
Mfr., Nichols & Clark
Hathorne, Mass.

Vacolite Models J & J-2
Mfr., Vacolite Company
3003 N. Henderson St.
Dallas 6, Texas

Zenith Miniature 75

Zenith Model Royal

Zenith Model Super-Royal

Zenith "Regent"
Mfr., Zenith Radio Corporation
5801 W. Dickens Ave.
Chicago 39

(All aforementioned hearing aids have vacuum tubes.)
Accepted hearing aids more than five years old have been omitted from this list for brevity.

Transistor Hearing Aids Accepted

Acousticon Model A-300	1 transistor and 2 tubes
Acousticon Model A-310	1 transistor and 2 tubes
Acousticon Model A-330	3 transistors
Acousticon Model A-335 Mfr., Dictograph Products Inc. 95-25 149th St. Jamaica 35, N. Y.	3 transistors
Audivox Model 71 Mfr., Audivox, Inc. 123 Worcester St. Boston 18	3 transistors
Beltone "Concerto" Model Mfr., Beltone Hearing Aid Co. 2900 W. 36th St. Chicago 32	3 transistors
Maico Transist-Ear Model O Mfr., The Maico Company, Inc. 21 N. 3rd St. Minneapolis 1	3 transistors
Micronic "All American" Hearing Aid Mfr., Audivox, Inc.—Successor to Western Electric Hearing Aid Division 123 Worcester St. Boston 18	3 transistors
Microtone Model T1 (Red Dot)	3 transistors
Microtone Model T1 (Yellow Dot)	3 transistors
Microtone Model T31 (Micro-Mite) Mfr., The Microtone Corporation 758 S. Mississippi River Blvd. St. Paul 1	1 transistor and 2 tubes
Otarion Model C-15	1 transistor and 2 tubes
Otarion Model D-1	3 transistors
Otarion Model F-22 Mfr., Otarion, Inc. 185-7 Ashford Ave. Dobbs Ferry, N. Y.	1 transistor and 2 tubes
Radioear Model 820 Mfr., E. A. Myers & Sons, Inc. 306 Beverly Rd. Mt. Lebanon Pittsburgh 16 Distr., Radioear Corporation 306 Beverly Rd. Mt. Lebanon Pittsburgh 16	3 transistors

Sonotone Model 1010	1 transistor and 2 tubes
Sonotone Model 1111 Mfr., Sonotone Corporation Elmsford, N. Y.	3 transistors
Telex Model 954	1 transistor and 2 tubes
Telex Model 956 Mfr., Telex, Inc. Telex Park St. Paul 1	3 transistors
Unex Model TR-3D Mfr., Nichols & Clark, Inc. Hathorne, Mass.	3 transistors
Zenith Model Royal-T	3 transistors
Zenith Model Super Royal-T Mfr., Zenith Radio Corporation 5801 W. Dickens Ave. Chicago 39	3 transistors

Semiportable Hearing Aids Accepted

Ambco Hearing Amplifier (Table Model)
Mfr., A. M. Brooks Co.
1222 W. Washington Blvd.
Los Angeles 7

Aurex Hearing Aids (three types)
Mfr., Aurex Corporation
1117 N. Franklin St.
Chicago 10

Precision Table Hearing Aid
Mfr., Precision Hearing Aids
5157 W. Grand Ave.
Chicago 39

Sonotone Model 50 Professional Table Set
Mfr., Sonotone Corporation
Elmsford, N. Y.

Society Transactions

CHICAGO LARYNGOLOGICAL AND OTOLOGICAL SOCIETY

Roland Russell, M.D., President

Stanton A. Friedberg, M.D., Secretary

Monthly Meeting, Feb. 1, 1954

Surgery in Carcinoma of the Hypopharynx. Dr. Irwin D. Horwitz, Dr. Arthur Loewy, Dr. Burton J. Soboroff, and Dr. Maurice F. Snitman.

Irradition therapy of carcinoma of the hypopharynx has not proved successful. Numerous large series of cases treated in this way and reported over a long period of time have shown uniformly disappointing results. Recent advances in medicine have permitted a return to surgical management of these tumors, with the promise of a much higher percentage of five-year cures. Therefore, we feel that surgical management should be given a much more extensive trial by the men in our specialty, to provide the patient with the greatest chance for survival. But survival alone is not the only objective. We feel that surgical management will also provide the best opportunity for early rehabilitation of a useful person. We cannot cite five-year survival figures in our own series but can only say that we are encouraged by the early postoperative results and anticipate a significant improvement in the ultimate outcome.

Electrodiagnostic-Therapeutic Modalities in Facial Nerve Paralysis. Dr. Arthur A. Rodriquez and Dr. Emanuel M. Skolnik.

Excellent prognostication of facial nerve paralysis, particularly Bell's palsy, has been obtained by means of faradic-galvanic testing and, more precisely, by electromyography. These tests have their greatest value if performed serially until the third week following onset, when dependence on the findings is unequivocal. It is emphasized that no therapy can be evaluated without prior electrodiagnostic testing, because of the wide variety of outcomes, from complete recovery in a few weeks to no recovery. Furthermore, the faradic-galvanic test alone is inadequate. It must be combined with electromyographic testing in order to truly evaluate the nerve status. Electromyography of facial muscles is more difficult than in limb muscles and must be performed only by the experienced.

Physical therapy is of value in facial nerve paralysis for its physiological benefits, its decongestive effects, maintenance of muscle tone, and for its retardation of atrophy, and retardation of deleterious chemical changes in denervated muscles.

Tracheotomy in Infancy. Dr. Paul H. Holinger, Dr. Kenneth C. Johnston, Dr. John A. Bigler, and Dr. Filmore Schiller.

The incidence of tracheotomy in infants under 1 year of age is increasing, due to broadening of indications, greater acceptance of tracheotomy as an adjunct to other therapy, and a lower mortality through improvements in surgical technique and in postoperative care of tracheotomized infants. Tracheotomy for inflammatory lesions is decreasing, but the incidence of tracheotomy for congenital and miscellaneous lesions is increasing. Of 62 infants under 1 year of age who required tracheotomy, congenital lesions were considered to be the cause of the respiratory obstruction in 32 cases (15 males and 17 females) and acquired lesions in 30 (21 males and 9 females). In 8 of the 30 infants in the "acquired" group, congenital anomalies were indirectly responsible for the tracheotomy, since it was necessitated after extensive surgical procedures performed in an attempt to correct gross anomalies of organs other than those of the respiratory system. There were 17 deaths in the series of 62 cases. Eight occurred in the miscellaneous group, principally in those operated upon for gross anomalies of other organs, three in the group of 17 congenital laryngeal anomalies, four in the group of 18 inflammatory lesions, and two in

the group of 8 neoplasms. Tracheotomy is generally looked upon as an emergency, life-saving procedure. However, in most cases it can be a planned, careful operation, preceded by the establishment of an airway, to avoid cerebral and surgical trauma. The post-tracheotomy period is the critical period during infancy.

DISCUSSION

DR. A. H. ANDREWS: There are a number of aspects of the subject presented by Dr. Holinger upon which one might dwell for the purpose of emphasis. One youngster he mentioned was interesting. The child was taken to a hospital with the story that he had been playing alone in a room when the mother heard him choke and cough. Examination by a resident demonstrated no symptoms or findings, and the mother was told to bring the child back the next morning. Again there were no symptoms or findings, and the mother was told that he was all right. She became angry, and, before an x-ray could be taken, she left the hospital.

Some six weeks later the child was admitted to Children's Memorial Hospital with the tentative diagnosis of acute laryngotracheal bronchitis, with the classic symptoms. Tracheotomy was needed. At the time of the bronchoscopy, I saw a shiny foreign body in the larynx, took hold of it with forceps, and, with gentle traction, withdrew it. It was the keeper of a safety pin. The child stopped breathing, and a small bronchoscope was passed alongside the pin, the airway established, and a tracheotomy was done, disregarding the safety pin. Next morning the trachea was exposed, and the pin was grasped by the posterior keeper limb and pulled up into the tracheotomy wound, perforating the anterior wall of the trachea with the anterior branch. This was cut off with wire cutters and the safety pin rotated out. The child had a recurrent larnygeal nerve paralysis afterward, which lasted for about six months, with complete recovery, and when the child was seen about a year after the operation, he was in perfect health. I do not feel that we can blame the tracheotomy on the removal of the foreign body. I do not believe that it is quite fair to imply that the tracheotomy was the result of removal of the foreign body.

The smallest infant upon which I have performed a successful tracheotomy weighed 4 lb. 15 oz. (2,267 gm.). It was impossible to pass the bronchoscope. A laryngeal grasping forceps was inserted and opened, rather forcibly dilating the stenosis, which was due to tough fibrous adhesions of the vocal cords in the anterior three-fourths of the larynx. It was obviously impossible to get a 3.5-mm. bronchoscope through, so the smallest intratracheal catheter was slipped through easily into the trachea. These tiny catheters should be included in the standard set-up in the bronchoscopic operating room, for just such cases, in which the bronchoscope cannot be passed. This child's larnyx was subsequently dilated, and after two years the tracheotomy tube was removed; that was two years ago. In this case the complaints were of difficulty in nursing. In the newborn infant the time of greatest work is when nursing, so that while the infant may be relatively asymptomatic, when nursing there is choking, coughing, and gagging, and that may be the presenting symptom of laryngeal obstruction.

I know of one fatality which, I believe, was due to frank neglect. The infant was tracheotomized on the second day of life and died on the third day. A special nurse had been assigned to the case. The supervisor removed the special nurse; the child was seen about 20 minutes later and seemed to be all right, and 20 minutes afterward was found dead. At autopsy the tracheotomy tube was found to be completely full of secretions. Great emphasis must be placed upon constant attention to the newborn infant with a tracheotomy.

With regard to postoperative care, at St. Luke's Hospital we have found that the newer types of aerosol generators, with a tracheotomy mask, have simplified the method of supplying humidity to these children, using oxygen or compressed air as a means of producing aerosol and preventing thickening and drying of secretions.

DR. BURTON J. SOBOROFF: One of the serious complications of tracheotomy in young infants and children is mediastinal emphysema and pneumothorax. I should like to ask Dr. Holinger whether this occurred in any of the cases in this series and, if such complications did arise, what therapy was used.

DR. PAUL H. HOLINGER: I should like to thank Dr. Andrews and Dr. Soboroff for their comments. In reply to Dr. Andrews, certainly there was nothing implied in the discussion of the infant tracheotomized to remove the safety pin. Obviously, when a tracheotomy is indicated, it should be done. It was so described merely to stress the fact that in foreign-body work in

small infants a tracheotomy is the great exception and not a routine procedure. As you know, there are institutions in which a treacheotomy is performed on any child under 2 years of age who has a foreign body, and the foreign body is removed by lower bronchoscopy rather than through the larynx. Foreign-body work is a peroral procedure, for the most part, in spite of the fact that the infant may be under 1 year of age or, as in a number of our cases, less than a week old when a foreign body has been removed from either the air or the food passages.

With regard to nursing care, Dr. Andrews has mentioned the key to the entire problem: teamwork, which is essential between resident, nurse, and, from the economic standpoint, the administration. The economics of the management of such children is an extremely serious problem. The fact that they do require constant care is the key to the problem, and for that reason we attempt to teach the mother as early as possible the management, care, aspiration, and cleaning of the tracheotomy tube, so that she may take the child home as soon as possible and continue its care at home. She is better able to give the child 24-hour nursing care than is the hospital, where, as you all know, from day to day the problem of economics becomes greater. The mother wants to take care of the child and can be taught to do so, even a small tracheotomized infant.

No anesthesia is used for the endoscopic procedure; the bronchoscope is used to establish the airway, and for the tracheotomy itself, generally procaine hydrochloride (Novocain) infiltration is all that is necessary.

Dr. Soboroff mentioned the problem of mediastinal emphysema and pneumothorax. One case of extensive emphysema occurred in the group and no cases of pneumothorax. I believe that one of the principal reasons for this is that the airway was established bronchoscopically before the tracheotomy itself was begun. There was occasional subcutaneous emphysema, of course, as part of the tracheotomy procedure, but, as a rule, this is not a significant complication, provided the incision is left open and not sutured tightly around the tracheotomy. With the airway established by the bronchoscope, there is no sucking of air into the mediastinum, as would occur with an obstructed airway during exposure of the trachea. I believe that occasionally extensive subcutaneous or mediastinal emphysema or a pneumothorax is due to the tracheotomy's being performed too low; the head is hyperextended when the bronchoscope is in place, and if the tracheotomy is done too low under those circumstances, it allows the incision to slide down to the mediastinum when the bronchoscope is removed and the head brought forward. Mediastinal emphysema then occurs. This serious complication reported in some articles can be avoided with a proper tracheotomy in the usual position.

Early Prosthetic Closure Following Maxillary Resection. DR. STANLEY H. BEAR and DR. ROLAND KOWAL.

The postoperative problem following maxillary resection or palatal antrotomy is discussed with measures used to obtain early rehabilitation of the patient. A simple, inexpensive temporary prosthesis is described, which is composed of a polyvinyl plastic sponge attached to an acrylic or plastic base or to the patient's own dentures. The conditions for using this type of temporary prosthesis and its advantages are presented.

DISCUSSION

DR. MAURICE F. SNITMAN: If one were to exclude the beneficial effects outlined by Dr. Kowal on the value of the prosthesis and apply it solely for the purposes of intracavity radium application, this prosthesis would be well worth the effort expended in its construction. After radical surgery of the maxilla for neoplastic disease, the intracavitary radium application is indicated. This procedure is simplified by this prosthetic mold in maintaining in position the radium needles or radon seeds.

Abstracts from Current Literature

Ear

THE PROBLEM OF THE BLUE EARDRUM, IDIOPATHIC HEMOTYMPANUM. W. R. JOHNSTON, Laryngoscope **63**:1096 (Nov.) 1953.

The most interesting subject of blue ear drum is reviewed clearly and thoroughly and two cases reported. No etiology is known. Its possible confusion with the anomaly of the jugular bulb extending into the middle-ear cavity causes the differential diagnosis to be most important.

Repeated inflation and myringotomy with removal of the reddish-brown fluid seem only to have a temporary effect. The mastoid seems to be a reservoir for this fluid, and mastoidectomy may be justified. In one of Johnston's cases this procedure helped but did not produce a complete cure, nor by it was he able to discover the bleeding point.

HITSCHLER, Philadelphia.

PRESERVATION OF HEARING IN SURGERY FOR CHRONIC EAR DISEASE: A CONSIDERATION OF FACTORS INVOLVED. ARTHUR L. JUERS, Laryngoscope **64**:235 (April) 1954.

The modified radical mastoidectomy is indicated in those cases in which there is attic disease not extending into the middle ear. Preservation of hearing is possible. The operation should not be delayed too long out of fear of the extension of the process, with resulting hearing loss or other complications.

The Lempert incision is preferred when the pathology is located in the attic and antrum. If there is much pneumatization, the postauricular approach may be preferred. In pneumatized mastoids, the matrix had best be removed in order to remove all pathology. In sclerosed ones, the matrix may be left in the medial attic (antral region).

The problem of the integrity of the ossicular chain and its relation to the postoperative hearing level is discussed and illustrative cases given.

A surgical procedure, myringostapediopexy, is described. In cases in which the incus has been removed, it is felt that better postoperative hearing is possible if the pars tensa is in contact with the stapes.

The operation described tries to assure such contact.

HITSCHLER, Philadelphia.

BILATERAL SUDDEN DEAFNESS. RICHARD R. LEHMANN, New York J. Med. **54**:1481 (May 15) 1954.

The case concerns Dr. N. Bethune, a Canadian surgeon, who became suddenly deaf while at the front in the Japanese-Chinese war. The cause is set down as probably a temporary angiospasm of the blood vessels in the labyrinth. Aged 49 years, this gentleman had suffered from malnutrition (he weighed 100 lb. [45.4 kg.]), vitamin deficiency, secondary anemia, and emotional disturbances due to the environment. "This condition must not be confused with Ménière's syndrome," which may have repeated attacks. In sudden deafness there is usually one severe attack, not likely to be repeated. There may or may not be vestibular reactions. E. P. Fowler Sr. analyzed 26 cases of sudden deafness in young people under 40. He does not assume a toxic neuritis but believes the acoustic nerve neuritis to be of unknown origin, with anoxia and ischemia due to a vascular spasm. Only 6 of Fowler's 26 patients suffered bilateral deafness, and he favors the idea that thrombosis or embolism in the internal auditory artery or a branch thereof is a possible primary cause. Psychogenic deafness is recognized also, but such factors as late syphilis and diseases of the central nervous system should be kept in mind. The prognosis is always grave, but there is a degree of recovery in many instances, if not full status. Sixteen references are offered to future investigators.

I. W. VOORHEES, New York.

QUANTITATIVE STUDY OF THE BRAIN OF A DEAF-MUTE. V. W. D. SCHENK, Rev. neurol. **89**:208, 1953.

A quantitative examination was made of the eighth nerve nucleus, the superior olive, Henschl's convolution, and the superior temporal and angular gyri of a 65-year-old man who had been a deaf-mute all his life. It was found that the ventral cochlear nucleus of the deaf-mute had a reduced number of cells even in comparison with cells of a deaf subject. However, the superior olive of the deaf-mute had more cells than that of a deaf subject. The number of cells (1.01 per square millimeter) in the cortex of the transverse temporal gyrus of the deaf-mute was considerably less than normal. In the angular gyrus the number of cells of the deaf-mute was 800.01 per square millimeter, as compared with a value of 700 to 1,200 in normal subjects. In the angular gyrus there was a diminution of the cells of the superficial layers.

BERLIN, Mount Vernon, N. Y. [A. M. A. ARCH. NEUROL. & PSYCHIAT.].

INFLAMMATION OF THE MIDDLE EAR CAUSED BY CANDIDA ALBICANS. K. TOMIĆ-KAROVIĆ and V. POPADIĆ, Schweiz. med. Wchnschr. **83**:59 (Jan. 17) 1953.

From material obtained on antrotomy and mastoidectomy in a 49-year-old farmer, candida albicans was isolated. It was also isolated from the pus of the middle ear of an 8-year-old girl. This case cleared under treatment with 3% boric acid. The authors could not find any report of inflammation of the middle ear caused by this micro-organism.

AMBERG, Rochester, Minn. [A. M. A. AM. J. DIS. CHILD.].

STUDIES ON BONE CONDUCTION IN OCCLUSION OF THE MEATUS AND IN CHRONIC SOUND CONDUCTION DEAFNESS. G. EVERBERG, Acta oto-laryng. **43**:517 (Dec.) 1953.

In 15 cases of conduction deafness thorough examination revealed no increase in the bone conduction above the normal. This indicates that the improved bone conduction is apparent, rather than real. It is based on the deafness to surrounding noise and the lack of a masking effect.

The improvement of hearing found for bone-conducting sound upon occlusion of the meatus is, however, considered to be a real phenomenon.

ROBERT LEWY, Chicago.

LOSS OF HEARING FOLLOWING TREATMENT WITH DIHYDROSTREPTOMYCIN OR STREPTOMYCIN. GUNNAR LIDEN, Acta oto-laryng. **43**:551 (Dec.) 1953.

Patients being treated for pulmonary tuberculosis and tuberculous meningitis were examined for hearing loss. These patients were treated with streptomycin and dihydrostreptomycin. The recruitment phenomenon was used as a test. In the group of patients who had pulmonary tuberculosis, all the patients who had a hearing loss demonstrated recruitment. It was reasoned, therefore, that the lesion was cochlear. In the group with a diagnosis of tuberculous meningitis, three of the patients had deafness but no recruitment. These therefore, it was reasoned, had retrocochlear meningitis with a meningitis form of deafness. A statistical study of the results indicated that dihydrostreptomycin is more likely to cause deafness than the original streptomycin.

ROBERT LEWY, Chicago.

SOME ASPECTS OF THE SYMPATHETIC NERVOUS SYSTEM IN RELATION TO THE INNER EAR. J. C. SEYMOUR and J. W. TAPPIN, Acta oto-laryng. **43**:618 (Dec.) 1953.

In a series of experiments Seymour and Tappin determined that stimulation of the cervical sympathetic nervous system produced a reduction in the cochlear microphonic potentials. Histologic studies of the appropriate specimens indicated that this resulted from diminution of endolymph secretion of an altered quality and that it was not the effect of lowered oxygen content in the organ of Corti.

They conclude that the homeostasis of the labyrinth is maintained by the sympathetic nervous system. Autonomic imbalance produces perceptible and definable tissue changes. This is a definite mode of production of some inner-ear disorders.

ROBERT LEWY, Chicago.

ON THE CHEMISTRY OF THE LABYRINTH: DOES THE ENDOLYMPH CONTAIN HYALURONIC ACID? T. VILSTRUP, G. VILSTRUP, and C. E. JENSEN, Acta oto-laryng., Supp. 109 (Dec.) 1953.

The labyrinths of piked dogfish were studied. None of these fish had been dead for more than 48 hours. Endolymph was withdrawn from the saccule, each of which contained about 0.5 cc. There was no admixture with the watery perilymph. The presence of large amounts of hyaluronic acid or a closely allied substance sensitive to hyaluronidase was demonstrated. This has an enormous water-binding capacity.

The test used was by incubation of the endolymph with testicular hyaluronidase, with resulting reduction of the viscosity of the mixture.

ROBERT LEWY, Chicago.

Pharynx

CHOICE OF ANESTHESIA FOR TONSILLECTOMY. S. H. AXELROD, Eye, Ear, Nose & Throat Month. **33**:36 (Jan.) 1954.

Basal anesthesia should be utilized for children, both for psychic reasons and as a prelude to smooth, uneventful anesthesia. Axelrod prefers paraldehyde administered in combination with olive oil and benzyl alcohol as a retention enema. Vinyl ether is used for induction, after which the patient is intubated orally under open-drop ether. The advantages of endotracheal intubation outweigh its disadvantages. The tube should be of correct size; inflatable cuffs should not be employed in children, and the tube should be sterilized adequately before use. With a meticulous atraumatic technique during the proper plane of anesthesia, endotracheal anesthesia in children provides a safer anesthesia and is without untoward effects to the delicate tissues of the larynx.

Local anesthesia is the method of choice for adults. Careful injection of the anesthetic agent is necessary in order to obtain a good anesthesia. Axelrod favors nerve-block anesthesia, with accurate anatomic instillation of the anesthetic agent. For those adults who reject a local anesthesia for tonsillectomy, general anesthesia with the endotracheal technique is a necessity.

JENNES, Waterbury, Conn.

THE TONSIL PROBLEM IN REVIEW. A. R. HOLLENDER, Eye, Ear, Nose & Throat Month. **33**:44 (Jan.) 1954.

Discussion of the functions of the tonsil must be limited to theoretic reasoning in the absence of factual knowledge on this subject. It is believed that there is a relationship between the tonsil and the ability to acquire immunity. In the medical treatment of tonsillitis, the new trends in therapy with utilization of antibacterial agents have substantially improved the prognosis of the disease. More frequent use of the laboratory for supportive diagnosis of the type of tonsillitis will be helpful in determining the correct therapy. The treatment of chronic tonsillitis is a problem in management, because it is difficult at times to decide whether a conservative or radical attitude should be adopted. There is no disagreement as to the value of tonsillectomy once the indications are absolute. Often tonsillectomy has been indicated as a failure on the basis of technical grounds. The author quotes Boies: "When a tonsil operation is performed by one adequately trained, and with good technique, it is a highly satisfactory procedure in terms of the end results. . . ." In selected cases which are unsuitable for tonsillectomy, roentgen-ray therapy has proved very useful.

JENNES, Waterbury, Conn.

SURGICAL MANAGEMENT OF MANDIBLE INVADED BY ORAL CANCER. L. T. BYARS, Surg., Gynec. & Obst. **98**:564 (May) 1954.

The extension of oral cancer on to the mucosa of the mandible calls for a properly planned surgical procedure which will include the removal of a necessary amount of mandibular bone, but which should not be needlessly destructive. There are three choices: (1) resection of the lesion with a superficial plate of bone (for minimal lesions), (2) segmental resection of the mandible (usually in continuity with neck dissection), and (3) complete disarticulation of the mandible. The basic consideration in arriving at a decision is whether or not the mandibular

canal, with its vessels, nerves, and lymphatics, has been invaded by cancer cells. Byars calls attention to the marked anatomic variation in the position of the mandibular canal in the normal jaw as compared with the edentulous jaw. Diagrams also illustrate variations in the type of incisions used for maximum exposure.

When simple segmental resection of the mandible is performed, the gap is bridged by insertion of a bar of stainless steel. The purpose of this is to render the postoperative course easier with respect to eating, breathing, and reduction of pain. In most cases this is a temporary splint, which is removed in two to six weeks. In some cases the bar may become permanent.

If a resection of the mandible is done with disarticulation at the temporomandibular joint, splinting may be accomplished by a temporary wire inserted into the mastoid process and into the cut end of the mandible. This is always removed in six weeks. With resections of the symphysis, the hyoid bone drops downward and backward, and anchorage of structures essential to the airway is lost. This is prevented by insertion of an internal bar between the mandibular segments and attachment of the hyoid bone to the center of the bar by means of wire.

FRIEDBERG, Chicago.

Larynx

VASCULAR RING: A CAUSE OF CONGENITAL STRIDOR. RICHARD W. SMITHELLS, Arch. Dis. Childhood **28**:204 (June) 1953.

The causes of congenital stridor are considered, and the suggestion is made that tracheal compression by vascular rings arising from congenital anomalies of the great vessels may not be as uncommon as hitherto supposed.

A case is described in which severe symptoms of tracheal and esophageal compression due to a bilateral aortic arch were dramatically relieved by operation.

KELLY, Milwaukee [A. M. A. AM. J. DIS. CHILD.].

THE INFANT WITH STRIDOR. JOHN APLEY, Arch. Dis. Childhood **28**:423 (Dec.) 1953.

Observations are recorded on 80 cases with stridor developing in early infancy. To determine the natural history of the condition, progress was assessed clinically and by ancillary methods for periods up to several years. Attention was directed not only to the sequence of any changes in the larynx but also to general physical and mental development.

Stridor occurred in 11 of 14 siblings in five families. In the whole series, there was a male preponderance in the ratio of five boys to three girls. The average birth weight of boys with stridor was significantly higher than that of girls with stridor and than that of unselected infants of either sex.

In seven cases a congenital cardiac malformation was present, though in only one was it the cause of stridor. Three patients in the series were Mongols; 16 others were mentally retarded.

Feeding difficulties occurred in half the total number. Pulmonary complications were frequent. Chest deformities developed in many cases but were almost invariably transient.

Eleven patients died, and in 10 necropsy was performed. Apart from two cases of meningomyelocele and one of thyroid enlargement, death was invariably due to pulmonary infection.

In the largest group of cases, stridor was produced by an anatomical anomaly which impaired the patency of the upper respiratory tract; in the majority of these the anomaly was epiglottic. In a second group, stridor was considered to be due to dysfunction of the nervous system. In a third group, stridor originated with an upper respiratory infection.

The mechanism of production of stridor in these groups is discussed, with particular reference to primary and secondary changes in the larynx. It is emphasized that in the investigation of infantile stridor it is essential to make early and repeated observations not only of the larynx and respiratory tract, but of the patient as a whole.

KELLY, Milwaukee [A. M. A. AM. J. DIS. CHILD.].

SOME CASES OF ACUTE OBSTRUCTIVE LARYNGOTRACHEAL BRONCHITIS. D. GOTTI, Clin. pediat. **35**:407 (June) 1953.

Nine children, 5 to 11 years old, from the same neighborhood in Bologna, developed over a period of five days acute laryngotracheobronchitis. One of the patients, a 9-year-old hypogenital and hyperthymic boy, died; an autopsy was done. In none of the cases could a definite bacterial causative agent be established. It is quite likely that filtrable virus may have been responsible for the infections.

HIGGINS, Boston [A. M. A. AM. J. DIS. CHILD.].

CHANGES IN BACTERIAL FLORA OF THE THROAT DURING STREPTOMYCIN THERAPY. WALTER GOETERS, Monatsschr. Kinderh. **101**:505 (Dec.) 1953.

One hundred thirty-seven children of all age groups received intramuscular streptomycin in doses of 0.5 to 1 gm.; 8 infants received a total of 3 gm. of oral streptomycin. Throat cultures revealed streptomycin-resistant micro-organisms, which composed 10 to 20% of the bacterial flora. The persistence of streptomycin-resistant organisms was proved, furthermore, by their growth on culture media containing 200 mg. of streptomycin per cubic centimeter. The percentage of resistant strains bore no relationship to the age of the patient but was dependent on the amount of the drug received by the patient.

The first appearance of streptomycin-resistant organisms occurred on the 15th day of treatment with doses of 0.5 gm., on the 10th day with 0.75 gm., on the 2d day with 1 gm., and with oral administration to young infants. Resistant organisms consisted of strains normally present in throat cultures. Monilia and Candida were prevalent.

Organisms dependent on streptomycin for growth were found in 64 patients when maximal dosage of the drug was used; they were also found in two nurses caring for the infants receiving oral streptomycin. In 5% of attending personnel (physicans, laboratory workers, teachers, and ward and clerical help), in 10% of untreated roommates of patients, and in 31% of nurses streptomycin-resistant strains were found.

Streptomycin-resistant strains had disappeared by 8 to 10 days after cessation of intramuscular therapy and in 3 to 4 weeks after oral treatment.

Comparable results were obtained in mouse experiments.

HARTENSTEIN, Syracuse, N. Y. [A. M. A. AM. J. DIS. CHILD.].

STENOSIS OF THE LARYNX IN INFANCY: HAEMANGIOMA OF THE LARYNX. O. B. RAMSE, Acta pædiat. **42**:65 (Jan.) 1953.

A 3-month-old girl suffered from difficulty in inspiration from birth. Attacks of dyspnea set in gradually, with stridor, cyanosis, and loss of consciousness. There were repeated remissions. Direct laryngoscopy revealed a bluish-black swelling in the region of the subglottis, and a postmortem examination showed a hemangioma in the larynx, with hemorrhage, tracheobronchitis, and atelectasis of the lungs. In connection with this case, a brief account is given of the symptomatology, diagnostic possibilities, and treatment of hemangioma in the larynx.

FROM THE AUTHOR'S SUMMARY [A. M. A. AM. J. DIS. CHILD.].

FUSION OF THE VOCAL CORDS AFTER PROTRACTED ENDOTRACHEAL INTUBATION. ERIC ZWERGIUS, Acta oto-laryng., Supp. 109 (Dec.) 1953.

Zwergius discusses the desirability of maintaining a clear airway in cases of barbiturate poisoning. He then gives the history of two cases of adhesion of the vocal cords resulting from protracted intubation. These patients were intubated for 146 and 258 hours, respectively. The tubes were shifted once a day and the intubation performed by the hospital anesthesiologist. It is believed that the epithelium of the cords is injured in the process and that this is followed by an inflammatory reaction. Other series of cases indicated that laryngeal trouble did not occur until after 24 hours of intubation. It was also shown that soft, rather than rigid, tubes should be used, as they cause less harm.

Treatment is by sharp separation of the fusion through the direct laryngoscope.

ABSTRACTOR'S COMMENT: Work reported by others and me indicates that the trouble might be avoided at the onset by not permitting laryngeal intubation for more than 24 hours. If further time is required for the airway, tracheotomy is indicated.

ROBERT LEWY, Chicago.

Nose

SURGICAL MANAGEMENT OF ANGIOFIBROMA OF NASOPHARYNX. ARNOLD J. KREMEN, Ann. Surg. **138**:672 (Oct.) 1953.

Angiofibromas of the nasopharynx distinctly occur in young pubescent boys, producing a symptom pattern of nasal obstruction, voice and hearing changes, and dangerous bleeding. The lesion grows progressively during the period of adolescence, but after maturity the tumor often regresses. The lesions do not exhibit the classic histological features of malignant neoplasms, but not infrequently they display the characteristics of a positional malignancy where progressive growth of the tumor expands the narrow confines of the nasopharynx, and the threat of repeated exsanguinating hemorrhage endangers the life of the patient.

A technique is presented for surgical management of angiofibromas of the nasopharynx by lateral nasopharyngostomy.

BANTIN, Omaha [A. M. A. AM. J. DIS. CHILD.].

DISEASES OF THE PARANASAL SINUSES IN CHILDHOOD. L. RUEDI, Schweiz. med. Wchnschr. **83**:1247 (Dec. 26) 1953.

The review deals briefly with ethmoiditis acuta necroticans (scarlet fever), Kartagener's syndrome, and the combination of bronchiectasis with chronic sinusitis with the familial fibrosis of the pancreas. Special attention is directed to the so-called occult silent sinusitis which is localized preponderantly in the maxillary sinuses. It is noted that the sinusitis is rather rarely "silent." The diagnosis is established by roentgen examinations, and routine examinations are recommended. Treatment is discussed.

AMBERG, Rochester, Minn. [A. M. A. AM. J. DIS. CHILD.].

THE TREATMENT OF DIPHTHEROID RHINITIS IN CHILDREN BY THE LOCAL APPLICATION OF FIBRINOLYTIC ENZYMES. E. CHELI, Clin. pediat. **35**:667 (Sept.) 1953.

Diphtheroid rhinitis is defined as the persistent crusty bloody fibrinoid exudate or the impetiginous crusting in and around the nasal cavity; it usually is a sequela of the common cold. Successful results are reported by the local application by a cotton pledget of a solution containing fibrinolytic enzymes, followed by similar application of an antibiotic. The fibrinolytic enzymes are of pancreatic origin, and are sold under the proprietary name Fibrinoclasi.

HIGGINS, Boston [A. M. A. AM. J. DIS. CHILD.].

Miscellaneous

TREATMENT OF BELL'S PALSY WITH CORTISONE. W. P. ROBISON and B. F. MOSS, J. A. M. A. **154**:142 (Jan. 9) 1954.

Most authorities feel that in patients suffering with severe Bell's palsy recovery is not likely to occur in less than several months. Robison and Moss treated two patients with cortisone, and prompt recovery occurred.

With one, a girl aged 13, treatment was started on the third day of paralysis. Three days after the cortisone therapy was begun the patient showed improvement that was obvious and gratifying. During this time 400 mg. of cortisone had been given. For the next 10 days 75 mg. of cortisone was given each day (a total dose of 1,150 mg.), with continuing improvement. Recovery was complete 19 days after onset.

Cortisone therapy was started one week after onset of the paralysis in the second patient, a child aged 5 years. Cortisone was given in diminishing doses, and recovery was complete on the 17th day.

According to Rothendler, "the beneficial action of cortisone in these patients can be assumed to be due to a reduction of congestion and related ischemia of the nerve and its sheath in the bony canal." The authors suggest the use of cortisone in the early stages of Bell's palsy.

ALPERS, Philadelphia [A. M. A. ARCH. NEUROL. & PSYCHIAT.].

DANGERS ASSOCIATED WITH BLOOD TRANSFUSION. LESTER J. UNGER, New York J. Med. **54**:1307 (May 1) 1954.

Dr. Unger is Director of the Blood and Plasma Bank at the New York University-Bellevue Medical Center. His paper was presented before the American Academy of Forensic Sciences in Chicago, Feb. 24, 1954. The great responsibility of everyone who orders or gives a blood transfusion is urgently stressed, and the statement that it "may do good, but can do no harm" is deplored, because there are inherent dangers often overlooked or not fully understood. For example, the mortality due to blood transfusions equals that due to anesthesia or appendectomy, and is set down as one death in 1,000 to 3,000 transfusions. Dangers begin with the manufacture of the equipment and continue before, during, and after the procedure and on into the following months! These may be grouped according to their origin: (1) at the donor center, (2) at the laboratory, and (3) at the patient's bedside. As to mistakes occurring at the donor center, mislabeling of the bottle or pilot tube is a likely human error; although if this item is checked, double-checked, and even triple-checked, the mistake should not occur. One must be sure that the blood in the bottle and the blood in the tube are identical. Both before and after the transfusion, all items of whatever kind should be cleared of error, and those through whose hands the clearing takes place should initial the cards attached. As to errors occurring in the laboratory, it is possible that a bottle labeled for patient A may receive the label of patient B. This may cost a life. Strangely, errors are more likely to occur at night and on holidays and week ends, when less experienced attendants are substituting for the regular personnel.

No donor's blood should be used until any Rh factor, of whatever kind, is tested and determined correct for the case in hand. Only Rh-negative blood should be given to Rh-negative patients. Moreover, Rh-positive blood should not be given to Rh-negative female patients from birth to the climacteric; otherwise, normal pregnancies may become impossible. However, this may be justified in cases in which the patient's life is at stake and temporizing is impossible. All tests for clumping must be carried out before a donor's blood may be considered compatible. Curious errors can occur; for example, an attendant whose name began with the letter B affixed this initial at the spot where the patient's blood group (O) should have been. Different colored tags for the four groups help prevent such an error. All transactions must be written and not merely oral. At the bedside there may be errors of omission, in which no label is attached to the withdrawn blood. Mislabeling is one of the seven deadly sins in transfusion work. Unger cites five cases in which such mishaps occurred. Under other sources of error, one finds the use of hemolyzed blood from storage, transmission of diseases, such as hepatitis, and the improper choice of a vein. The vein chosen should always be peripheral, to avoid infection with resultant gangrene. An important item is the use of calcium gluconate to aid coagulation at the site of bleeding. Large amounts of transfused blood may be run into the body and yet hemorrhage will persist. Ten cubic centimeters of a 10% solution of calcium gluconate should be administered intravenously and may be repeated after each 1,000 cc. of transfused blood. In conclusion, transfusions of blood are not to be ordered indiscriminately. Indications, therefore, should be definite and certain, and a transfusion should not merely be given to "be doing something," regardless of the consequences, save when a patient is near death. Transfusion of whole blood is a highly specialized field and is best performed by a physician who does it daily and not merely occasionally.

I. W. VOORHEES, New York.

BRONCHOPULMONARY INFECTION TREATED WITH THE DIETHYLAMINOETHYL ESTER HYDRIODIDE OF PENICILLIN G: REPORT OF NINETY-SEVEN CASES TREATED. CRAIG N. SMITH and JOHN STAIGE DAVIS JR., New York J. Med. **54**:1464 (May 15) 1954.

Smith and Davis have treated 97 patients with acute and chronic bronchopulmonary infection in St. Luke's Hospital, New York City. After many trials, long-acting repository forms of penicillin were reduced to only three: sodium, potassium, and procaine penicillin. The new form, the diethylaminoethyl ester hydriodide of penicillin G (Neo-Penil), appears to have a direct affinity for lungs. It is an ester, rather than a salt, and is found in sputum six hours after injection. The study covers one year and lists 2 cases of lung abscess, 10 of bronchitis, 7 of bronchiectasis, and 78 of pneumonia. Out of 25 patients with Pneumococcus pneumonia, 19 were "successfully treated" with Neo-Penil (500,000 to 1,000,000 units daily) for an average of 10.5 days and a hospital stay of some 14 days. Untoward reactions were confined to urticaria and a

macular pruritic rash except in one patient, who had a metallic taste after 30 seconds, tonic and clonic seizures, loss of consciousness, and no pulse. Intravenous epinephrine (dose not given) brought him promptly to complete recovery. It was thought that direct injection into a blood vessel was responsible for this phenomenon. Thirteen references to the literature seem to prove the reliability of this treatment, wherein 92 were relieved, with success, while 5 were regarded as unimproved. "It is suggested that Neo-Penil is a useful adjunct to the treatment of bronchopulmonary infection."

I. W. Voorhees, New York.

Eight Fatal Anaphylactic Reactions to Penicillin. Abraham Rosenthal, New York J. Med. **54**:1485 (May 15) 1954.

Dr. Rosenthal is Assistant Medical Examiner, Borough of Brooklyn. He states that misadventures with penicillin, probably due to indiscriminate use, are being reported with "shocking rapidity." Fatalities are not always the aftermath of penicillin injections, and its use by mouth may lead at least to sensitization. One should always ask about allergic instances before proceeding with treatment. One may thus elicit a history of eruptions, swollen joints, rashes, blotching, and apnea. Asthma contraindicates the administration of antibiotics generally. Skin tests should be made. A reaction indicates that penicillin should be omitted or that a different antibiotic should be chosen.

The recital of these eight cases is well done and illuminates the importance of the subject. "Penicillin in any form or by any route must be preceded by a careful inquiry into the past history of the patient with respect to previous use of penicillin or the existence of an allergic state of any type." Five references are cited in support of the thesis of this article.

I. W. Voorhees, New York.

Surgical Treatment of Epithelial Tumors of the Parotid Gland. R. W. Buxton, J. H. Maxwell, and A. J. French, Surg., Gynec. & Obst. **97**:401 (Oct.) 1953.

Buxton and his associates have carefully reviewed the records of 280 patients with neoplasms of the parotid gland. The benign growths listed include mixed tumors, papillary lymphoid cystadenomas, serous-cell adenomas, acidophilic-cell adenomas, and the benign mucoepidermoid tumors. Wide local excision, with efforts to preserve the facial nerve, has been found satisfactory.

Squamous-cell adenomas and adenocarcinomas are best treated with wide excision and concomitant radical neck dissection. The facial nerve may have to be sacrificed in such cases, though preservation of the nerve may be attempted in certain instances.

The lymphoepitheliomas in this group were characteristically highly malignant, rapidly causing death, and it is suggested that lymphoepithelioma of the parotid gland is probably not biologically equivalent to that of the pharynx.

Friedberg, Chicago.

Esophageal Diverticula. F. H. Lahey and K. W. Warren, Surg., Gynec. & Obst. **98**:1 (Jan.) 1954.

Lahey and Warren summarize their experiences with operations upon 365 patients with pharyngoesophageal pulsion diverticula and 9 patients with epiphrenic pulsion diverticula. Since this almost certainly represents the largest series of its kind in medical literature, the article warrants careful study.

Dr. Lahey's preference for the two-stage operative procedure on pharyngoesophageal diverticula is well known. The technique of surgery is outlined in detail, with emphasis upon the necessity for complete dissection of the muscle fibers which overly the posterior and right aspects of the sac. It is the authors' contention that attempts to perform this meticulous dissection in a one-stage procedure are much more difficult and more apt to be incomplete than in the two-stage operation. Any failure to remove the muscle fibers entirely will promote a chance of recurrence of the diverticulum. There are numerous illustrations of the anatomical features peculiar to this problem. There were but two operative deaths in the entire series and a very low rate of recurrence of the diverticula.

Friedberg, Chicago.

PEPTIC STENOSIS OF THE ESOPHAGUS. E. B. BENEDICT and J. E. GILLESPIE, Surg., Gynec. & Obst. **98**:494 (April) 1954.

This report from the Massachusetts General Hospital represents an analysis of 100 patients with benign stenoses of the lower esophagus of unknown etiology. Lesions due to acids, caustics, achalasia, trauma, surgery, etc., were excluded. There were 60 males and 40 females in the group. Peptic stenosis of the esophagus is thought to be due to the abnormally prolonged contact of gastric juice with the region above the cardia of the stomach. Whereas it may occur in a normal person, it is more likely to occur in those with a so-called ulcer diathesis.

Esophageal hiatus hernia of the sliding type and excessive vomiting or regurgitation from relaxation of the cardia are the two conditions in which gastric juice is most prone to affect in the lower esophagus. Esophagitis was present in all the patients, and 42 showed evidence of ulceration. For this reason it is suggested that symptomatic hiatal hernias which do not respond to other measures should be repaired surgically.

Bouginage is the most satisfactory treatment but should be combined with adequate medical management. Theoretically, gastrectomy for gastroduodenal ulcers should be of value in preventing peptic stenosis of the esophagus. The series analyzed in this paper does not support this thesis.

The three indications for surgical intervention in peptic stenosis of the esophagus are (1) failure of bouginage, (2) severe hemorrhage, and (3) perforation. FRIEDBERG, Chicago.

THE CHANGING PATTERN OF OTOLOGY AND LARYNGOLOGY. VICTOR LAMBERT, J. Laryng. & Otol. **68**:63 (Feb.) 1954.

The decreasing need for temporal bone surgery as a treatment for suppurating ears can be attributed to several factors, most important of which is the advent of chemotherapy and antibiotics. However, this has been responsible for added problems in the recognition and management of intracranial complications of suppurative temporal bone disease. This has called for closer teamwork between the otolaryngologist and the neurosurgeon.

While the pattern of surgical otology has been changing, the medical aspect of the specialty, namely, audiology, has been growing, and it will be necessary for the otologist of tommorow to understand and speak the language of the audiologist, lest he lose the leadership of the specialty.

In regard to laryngology, the scene is dominated by the problem of malignant disease of the larynx and laryngopharynx. The latter, indeed, is a discouraging problem; the answer to which neither surgery nor irradiation can claim. It is Lambert's plea that more of these cases come to surgery and that said surgery be performed by the otolaryngologist.

The decline in the incidence of diphtheria and the increase in the number of types of painful ulcerative conditions of the buccal cavity and larynx have also contributed to the specialty's changing pattern. LEJEUNE and NORMANN, New Orleans.

CHANGES IN THE NASAL CYCLE UNDER STELLATE GANGLION BLOCK. PAUL STOKSTED and KNUD ANKER THOMSEN, Acta oto-laryng., Supp. 109 (Dec.) 1953.

Stoksted and Thomsen describe a posterior approach technique of the stellate ganglion block. After this block has been performed, they describe changes in the nasal mucosa and the nasal cycle, using a system of rhinometry for this determination. On the side of the block there is a marked increase in nasal resistance. There is a slight increase on the contralateral side. The effect of the block can be traced for about two hours. ROBERT LEWY, Chicago.

Books

Atlas of Exfoliative Cytology. By George N. Papanicolaou, M.D., Ph.D. Price, $18.00. Pp. 235, with 36 colored plates. Harvard University Press, Cambridge 38, Mass., 1954.

This work is an expression of years of fundamental and painstaking research on exfoliative cytology of the female generative tract and other systems of the body by Dr. George N. Papanicolaou.

The text is brief, as it should be in an atlas. It includes a short historical review, an outline of the technical procedure used in preparing and staining the various secretions and excretions, a dissertation on the cytological criteria for the diagnosis of cancer, and a description of normal and abnormal cell forms from various tissues and organs of the body, with emphasis on cancerous cells. The atlas contains a total of 36 colored plates, 24 of which are drawings and 12 photomicrographs. The distribution of the plates is as follows: 12, female generative system; 4, urinary system; 5, respiratory system; 5, alimentary system; 2, mesothelial-lined cavities; 2, mammary glands; 1, histiocytic cells; 1, cells in pregnancy; 1, irradiation changes; 1, multinucleated cells, and 2, mitoses. Each plate is accompanied by an explanation of the figures together with a succinct dissertation on the subject matter illustrated.

From a physical point of view the atlas is most attractive. The loose-leaf arrangement is excellent, for it will enable additions and deletions with minimum distortion of the work and minimum cost to both the publisher and the purchaser. Both the colored drawings and photomicrographs are beautifully reproduced. From a scientific point of view, the subject matter is covered accurately and authoritatively. The completion of any research problem is its publication in a manner so forthright that it may be understood by all. This, Dr. Papanicolaou has accomplished with masterful skill.

All in all, this reviewer is much impressed with the book and recommends it highly to anyone interested in the diagnosis of cancer.

Anatomy for Surgeons: Volume 1; The Head and Neck. By W. Henry Hollinshead, Ph.D. Price, $12.00. Pp. 560, with 326 illustrations. Paul B. Hoeber, Inc., 49 E. 33rd St., New York 16, 1954.

This book is presented in a most agreeable manner. The author indicates in his preface that the intent is to describe and interpret the anatomic facts and concepts which should be useful to the surgeon. It is presented in simple, readable language and illustrated profusely with many pen-and-ink drawings to emphasize the text. In each subdivision surgical procedures plus the associated clinical problems are amply presented, so that in addition to being a book on anatomy, it is actually a clinicoanatomic presentation of extreme value to the surgeon. Many anomalies and abnormalities are clearly presented in both the text and illustrations. The book has the advantage of having coordinated in its production a large group of collaborators from the staff of the University of Minnesota and the Mayo Clinic.

Chapter 1 deals with the cranium. The various structures, organs, nerves, arteries, and veins are described thoroughly, and also the many variations that may occur in these structures. Prolific references to the most current literature are included in the descriptive matter throughout the chapter, not only in relation to the abnormalities per se but also to their direct influence on the symptomatology and various pathologic processes. The second chapter, dealing with the orbit, follows the general structure of the first chapter, and it presents anatomic, physiologic, pathologic, and neurologic interrelationships of particular interest to the ophthalmologist. There are chapters on the ear, nose, paranasal sinuses, the fascia and fascial spaces of the head and neck, the face, the jaws, palate and tongue, the pharynx, larynx, and, lastly, the neck. After each chapter there is an extensive table of references and an extremely ample index. The type is easily read, and the book may be well recommended not only to students but also to the general practitioner and surgeon.

Physiological Acoustics. By Ernest Glen Wever and Merle Lawrence. Price, $10.00. Pp. 454. Princeton University Press, Princeton, N. J., 1954.

This new book by Wever and Lawrence emphasizes the ear as an acoustic instrument, and describes in great detail the mechanism of sound conduction to the hair cells of the inner ear. The book presents a much needed integration of many physical experiments on the mechanics of sound conduction. There are seven chapters, including an excellent glossary. Otologists and audiologists should consider this book important reading. Considerable and excellent treatment is accorded the following subjects: the middle ear as a transformer, the nature and locus of distortion in the ear, effects of air pressure on the ear, sound entrance into the cochlea, conduction in the cochlea, cochlear patterns, and the stimulation process.

A complete chapter is devoted to conductive deafness, particularly otosclerosis and the fenestration operation. The authors review auditory theory and present their own thinking in the form of the volley theory. There is much in this book which makes its publication worth while and a definite contribution to otology.

A Manual on Cardiac Resuscitation. By Robert M. Hosler, M.D. Price, $4.00. Charles C Thomas, Publisher, 301-327 E. Lawrence Ave., Springfield, Ill., 1954.

The manual covers everything pertaining to cardiac resuscitation that the practicing physician needs to know. For instance, some of the headings are "Etiology," "Preventive Measures," "Danger Signals," and "Technique of the Actual Procedure."

Particular points of the manual to be noted are the following: (1) It is brief and to the point. It can be read easily and quickly. (2) It gives all the essentials and avoids the too technical. It is written for the average physician rather than for the research physiologist or anatomist.

It should be a "must" for anyone who operates.

French's Index of Differential Diagnosis. Edited by Arthur H. Douthwaite, M.D., F.R.C.P. Seventh edition. Price, $20.00. Pp. 899, text; pp. 146, index; 731 illustrations (200 in color). Williams & Wilkins Company, Mount Royal and Guilford Aves., Baltimore 2. Agent in England: John Wright & Sons, Ltd., 42-44, Triangle West, Bristol 8, 1954.

Histology. Edited by Roy O. Greep, Ph.D., with 13 contributors. Price, $15.00. Pp. 918, with 648 illustrations. The Blakiston Company, Inc., 575 Madison Ave., New York 22, 1954.

Directory of Otolaryngologic Societies *

FOREIGN AND INTERNATIONAL

Canadian Otolaryngological Society

(Société Canadienne d'Otolaryngologie)

President: Dr. D. E. S. Wishart, 170 St. George St., Toronto
Secretary: Dr. W. Ross Wright, 361 Regent St., Fredericton, N. B.
Place: Minaki Lodge, Minaki, Ont.

International Bronchoesophagological Society

President: Dr. André Soulas, 184 Avenue Victor Hugo, Paris 16.
Secretary: Dr. Chevalier L. Jackson, 3401 N. Broad St., Philadelphia 40.
Meeting: Third International Congress of Bronchoesophagology.
Place: Lisbon, Portugal. Time: Oct. 10-13, 1954.
President of Congress: Dr. Iberto Luis de Mendonca.
Secretary of Congress: Dr. Antonio Da Costa Quinta, Avenida de Trinidade, Lisbon 20.

International Congress of Audiology

Place: Leyden, Netherlands.
General Secretary: Dr. H. C. Huizing, 182 Oostersingel, Groningen, Holland.

International Course in Paedo-Audiology

Place: Groningen, Netherlands.
General Secretary: Dr. H. C. Huizing, 182 Oostersingel, Groningen, Holland.

Pan-American Association of Oto-Rhino-Laryngology and Broncho-Esophagology

President: Dr. Juan Manuel Tato, Azcuenaga 235, Buenos Aires, Argentina.
Secretary: Dr. Chevalier L. Jackson, 3401 N. Broad St., Philadelphia 40.
Meeting: Fifth Pan-American Congress of Oto-Rhino-Laryngology and Broncho-Esophagology.
Place: San Juan, Puerto Rico. Time: February, 1956.
President of Congress: Dr. Juan H. Font, Medical Arts Building, San Juan.

Sixth International Congress of Otolaryngology

President: Dr. Arthur W. Proetz, 3720 Washington Blvd., St. Louis.
General Secretary: Dr. Paul H. Holinger, 700 N. Michigan Ave., Chicago 11.
Place: Hotel Statler, Washington, D. C. Time: May 5-10, 1957.

NATIONAL

American Medical Association, Scientific Assembly, Section on Laryngology, Otology and Rhinology

Chairman: Dr. Francis W. Davison, Geisinger, Memorial Hospital, Danville, Pa.
Secretary: Dr. Hugh A. R. Kuhn, 112 Rimbach St., Hammond, Ind.
Place: Atlantic City, N. J. Time: June 6-10, 1955.

* Secretaries of societies are requested to furnish the information necessary to keep this list up to date.

AMERICAN ACADEMY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

President: Dr. Walter H. Theobald, 307 N. Michigan Blvd., Chicago 1.
Executive Secretary-Treasurer: Dr. William L. Benedict, 100-1st Ave. Bldg., Rochester, Minn.
Place: Waldorf-Astoria Hotel, New York. Time: Sept. 19-24, 1954.

AMERICAN BOARD OF OTOLARYNGOLOGY

President: Dr. Frederick T. Hill, Professional Building, Waterville, Maine.
Secretary-Treasurer: Dr. Dean M. Lierle, University Hospitals, Iowa City.
Examinations: Waldorf-Astoria Hotel, New York, Sept. 13-17, 1954; Hotel Marshall, Richmond, Va., March 6-10, 1955; Palmer House, Chicago, October, 1955.

AMERICAN BRONCHO-ESOPHAGOLOGICAL ASSOCIATION

President: Dr. Clyde A. Heatly, 11 N. Goodman St., Rochester, N. Y.
Secretary: Dr. F. Johnson Putney, 1719 Rittenhouse Sq., Philadelphia 3.
Place: Hollywood Beach Hotel, Hollywood, Fla. Time: March 15-16, 1955 (afternoons only).

AMERICAN LARYNGOLOGICAL ASSOCIATION

President: Dr. Henry B. Orton, 224 Delavan Ave., Newark 4, N. J.
Secretary: Dr. Harry P. Schenck, 326 S. 19th St., Philadelphia 3.
Place: Hollywood Beach Hotel, Hollywood, Fla. Time: March 13-14, 1955.

AMERICAN LARYNGOLOGICAL, RHINOLOGICAL AND OTOLOGICAL SOCIETY, INC.

President: Dr. Kenneth M. Day, 121 University Place, Pittsburgh.
Secretary: Dr. C. Stewart Nash, 708 Medical Arts Bldg., Rochester 7, N. Y.
Place: Hollywood Beach Hotel, Hollywood, Fla. Time: March 15-16, 1955 (mornings only).

SECTIONS:

Eastern.—Chairman: Dr. Daniel S. Cunning, 118 E. 53rd St., N. Y. 22.
Place: Hotel Warwick, Philadelphia. Time: Jan. 7, 1955.

Southern.—Chairman: Dr. William C. Wolfe, 332 W. Broadway, Louisville 2.
Place: Medical School Auditorium, Charlottesville, Va. Time: Jan. 22, 1955.

Middle.—Chairman: Dr. French K. Hansel, 634 N. Grand Blvd., St. Louis 3.
Place: Sheraton-Cadillac Hotel, Detroit. Time: Jan. 24, 1955.

Western.—Chairman: Dr. Guy L. Boyden, 1735 N. Wheeler Ave., Portland 12, Ore.
Place: The Town House, Los Angeles. Time: Jan. 15-16, 1955.

AMERICAN OTOLOGICAL SOCIETY, INC.

President: Dr. D. E. Staunton Wishart, 170 St. George St., Toronto 5, Canada.
Secretary-Treasurer: Dr. John R. Lindsay, 950 E. 59th St., Chicago 37.
Place: Hollywood Beach Hotel, Hollywood, Fla. Time: March 17-18, 1955.

AMERICAN OTORHINOLOGIC SOCIETY FOR THE ADVANCEMENT OF PLASTIC AND RECONSTRUCTIVE SURGERY, INC.

President: Dr. Matthew S. Ersner, 1915 Spruce St., Philadelphia 3.
Secretary: Dr. Louis Joel Feit, 66 Park Ave., New York 16.
Place: Waldorf-Astoria Hotel, New York. Time: Sept. 19, 1954.

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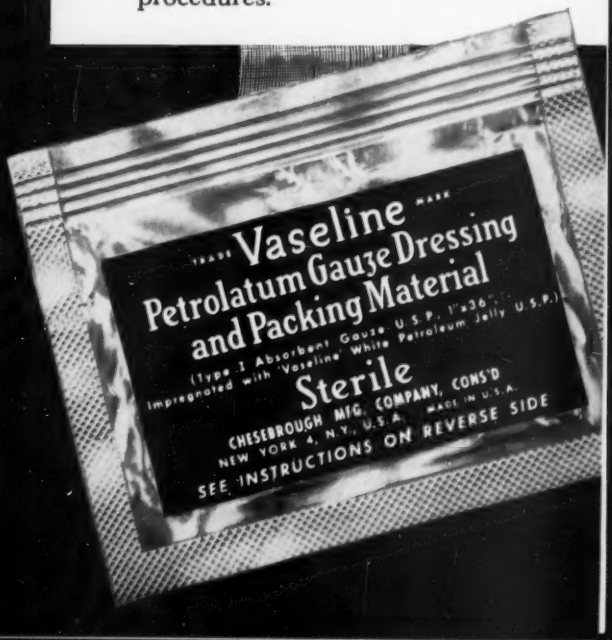
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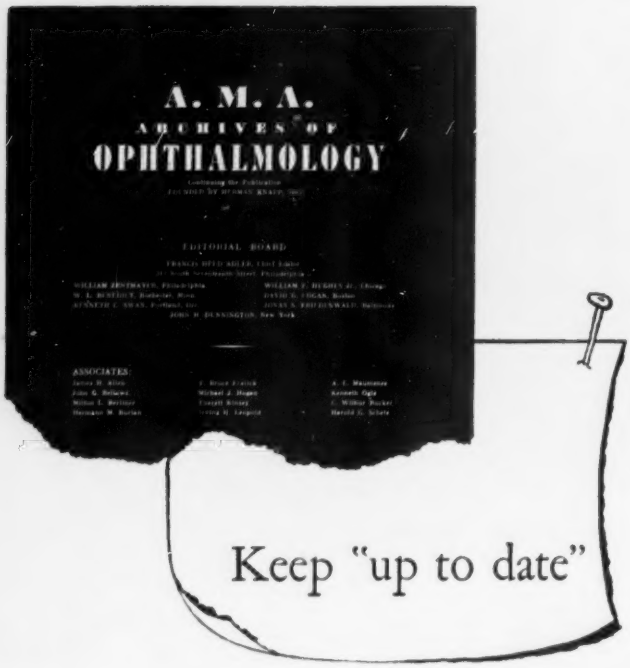

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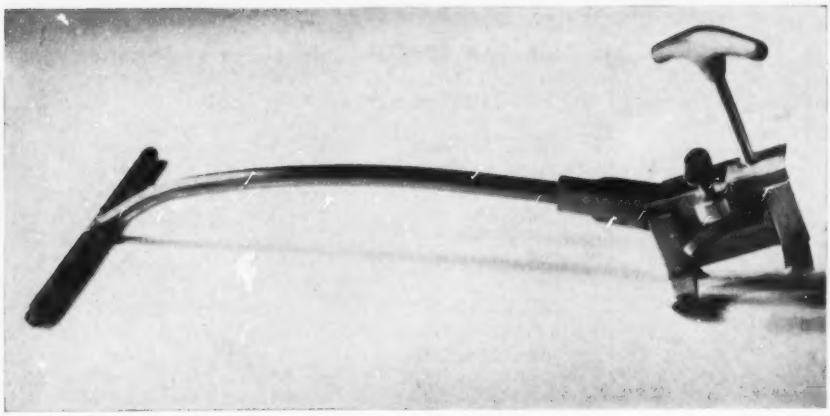

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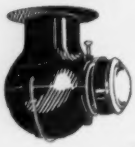

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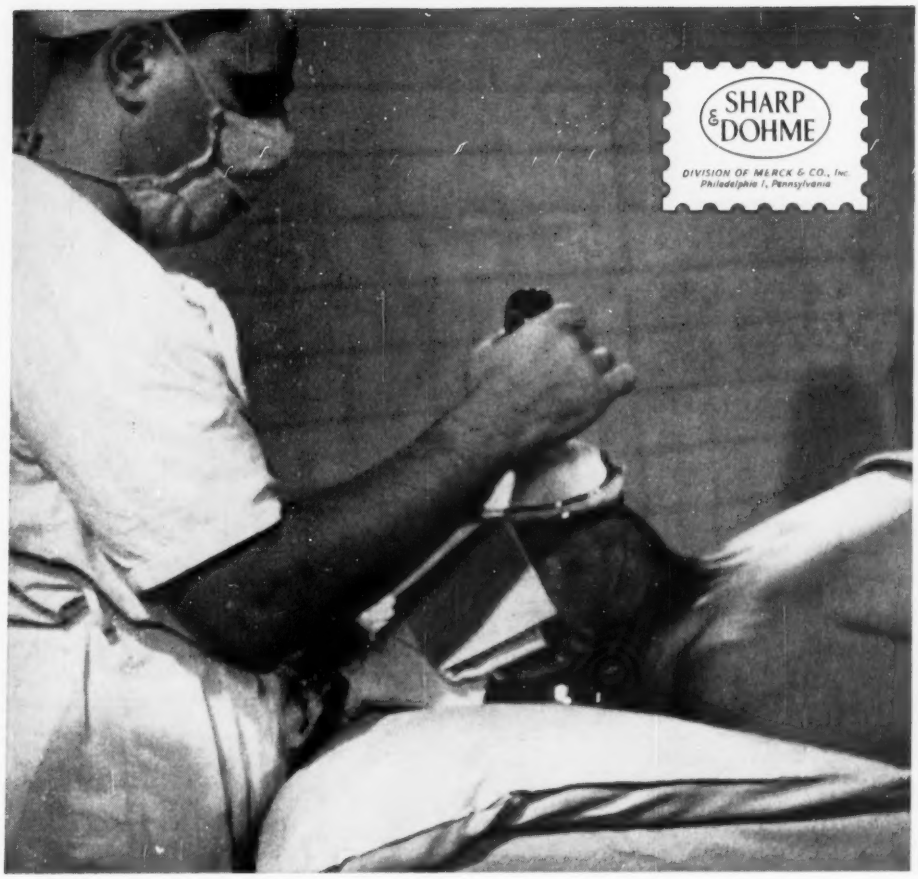

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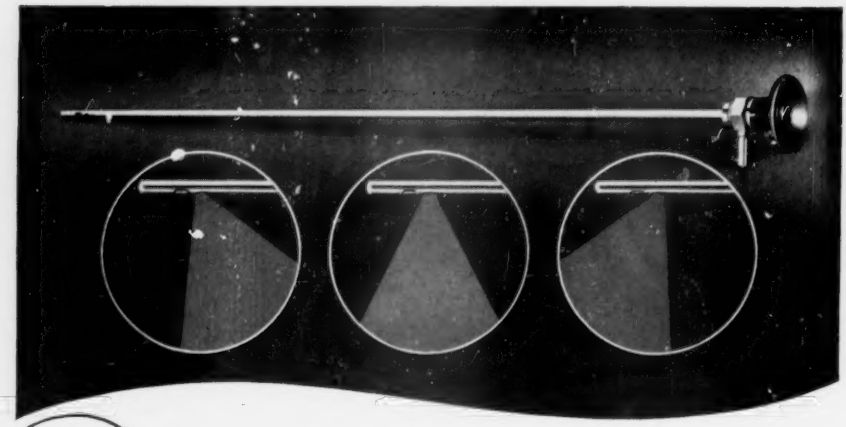

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